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NOTES

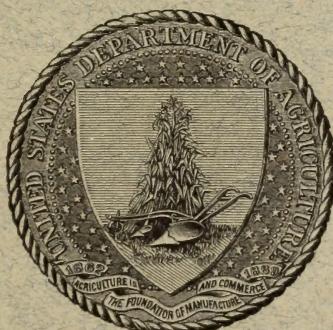


ON

THE FOREST CONDITIONS OF PORTO RICO.

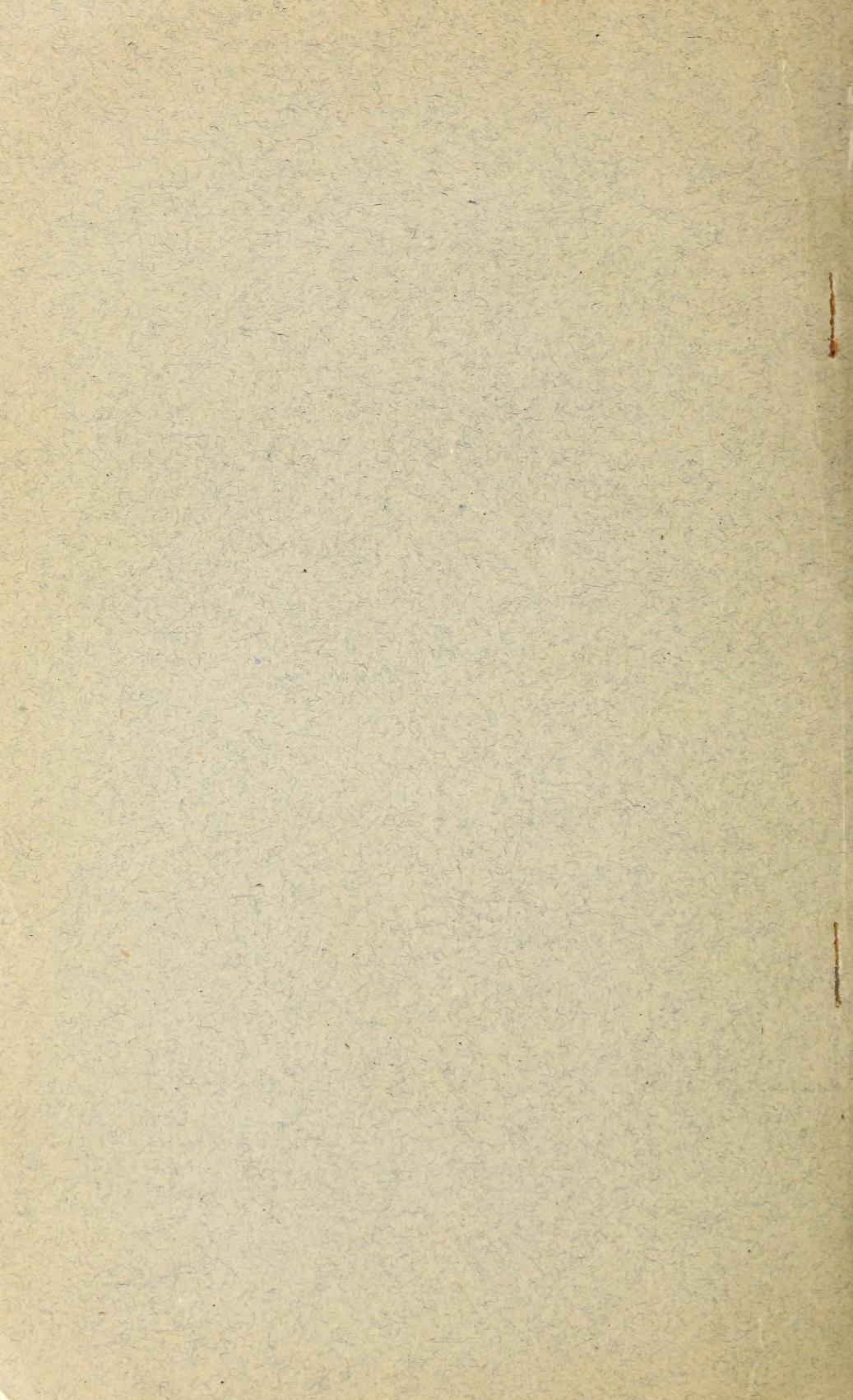
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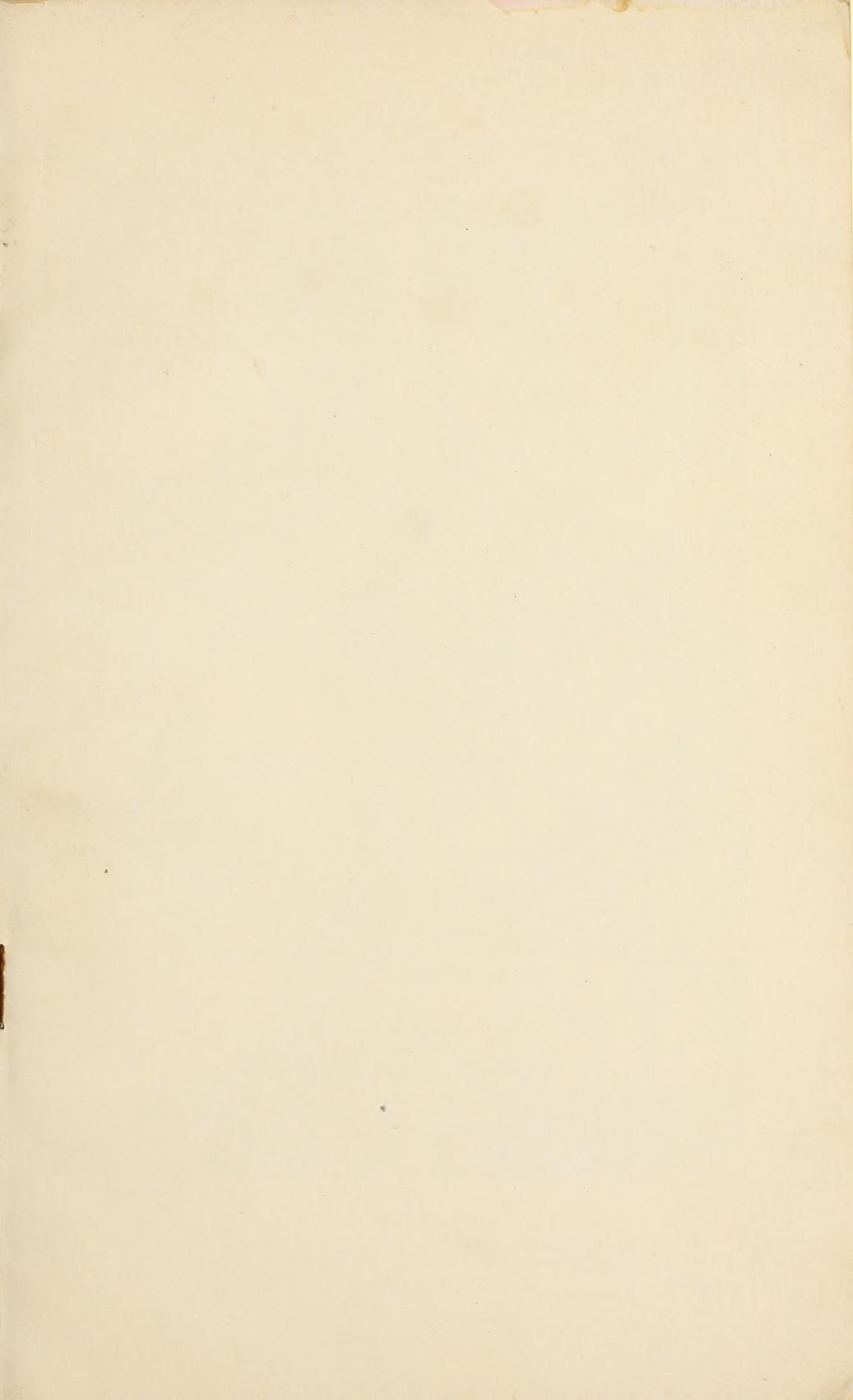
ROBERT T. HILL,
GEOLOGIST, U. S. GEOLOGICAL SURVEY.

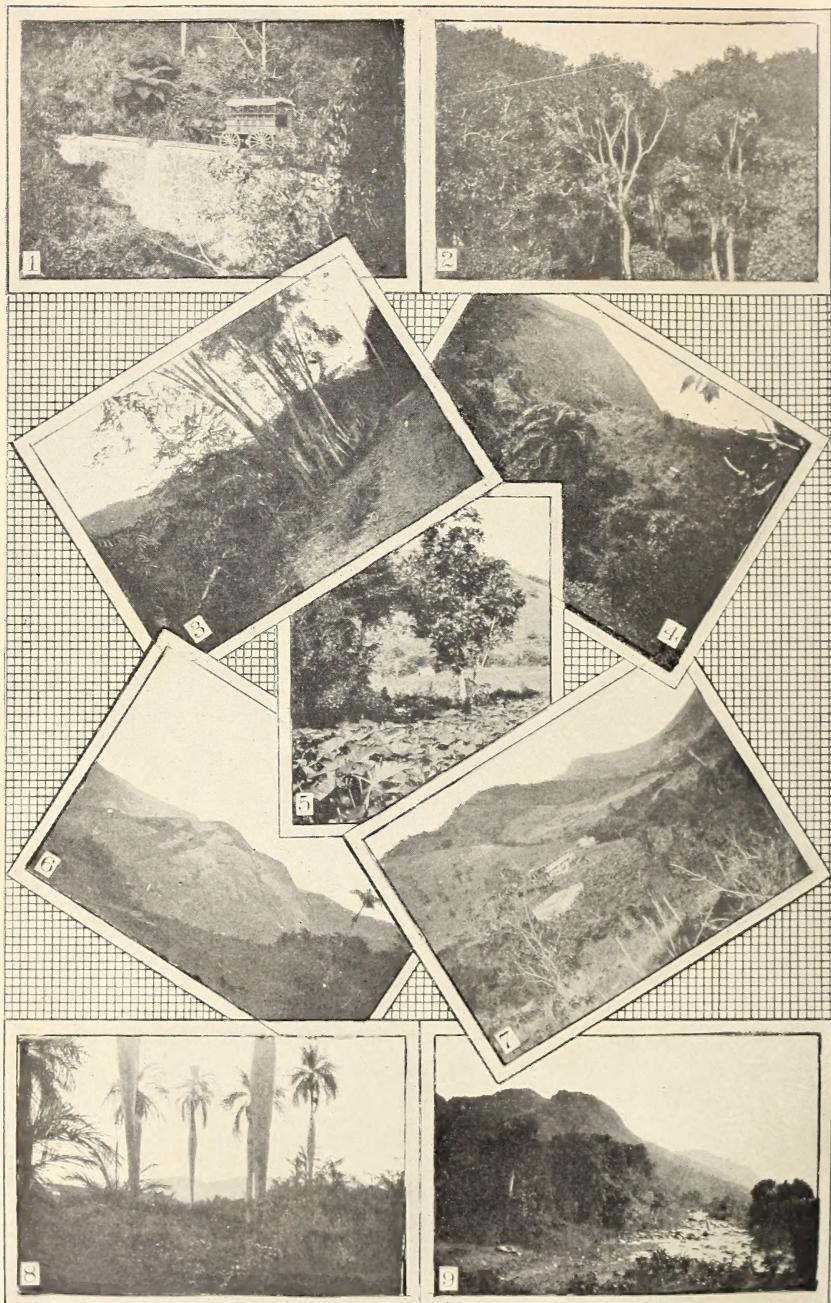


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CHARACTERISTIC VIEWS OF PORTO RICO.

1. Undergrowth; view along military road.
2. Coffee plantation, showing shade trees above, coffee bushes below.
3. Bamboo.
4. Central mountains near Cayey.
5. Cultivation of Yantia.
6. Tobacco culture near Cayey.
7. Central mountains south of Adjuntas.
8. Palm trees.
9. View in Sierra Luquillo.

BULLETIN NO. 25.

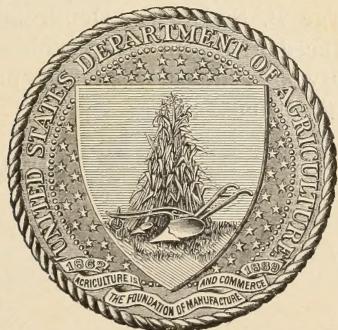
U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, FORESTER.

NOTES

THE FOREST CONDITIONS OF PORTO RICO.

BY

ROBERT T. HILL,
GEOLOGIST, U. S. GEOLOGICAL SURVEY.



WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., June 1, 1899.

SIR: I have the honor to transmit herewith a report entitled "Notes on the Forest Conditions of Porto Rico," by Mr. Robert T. Hill, of the United States Geological Survey, and to recommend its publication as Bulletin No. 25 of this Division. While the report is in no sense final or complete, it contains a preliminary statement sufficiently full to answer the great majority of questions of immediate interest concerning forestry in Porto Rico. It embraces the results of observations made during a rapid reconnaissance through the military department of Porto Rico by Mr. Hill in January, 1899, during which he became familiar with its forests, and by inquiry among various persons engaged in wood-working trades obtained valuable information as to the qualities and uses of the native timbers. The report contains not only a clear statement of the forest resources of Porto Rico and the extent of its timber lands, but also such succinct descriptions of the physical features of the island as are necessary for an understanding of its forest problems.

In the study and description of specimens of the native woods, reproductions of fifteen of which are presented in this bulletin, Mr. Hill was assisted by Mr. George B. Sudworth, Dendrologist of the Division. The woods are reproduced by a process by which the impressions are made directly from the woods themselves. This process is herein used, it is believed, for the first time.

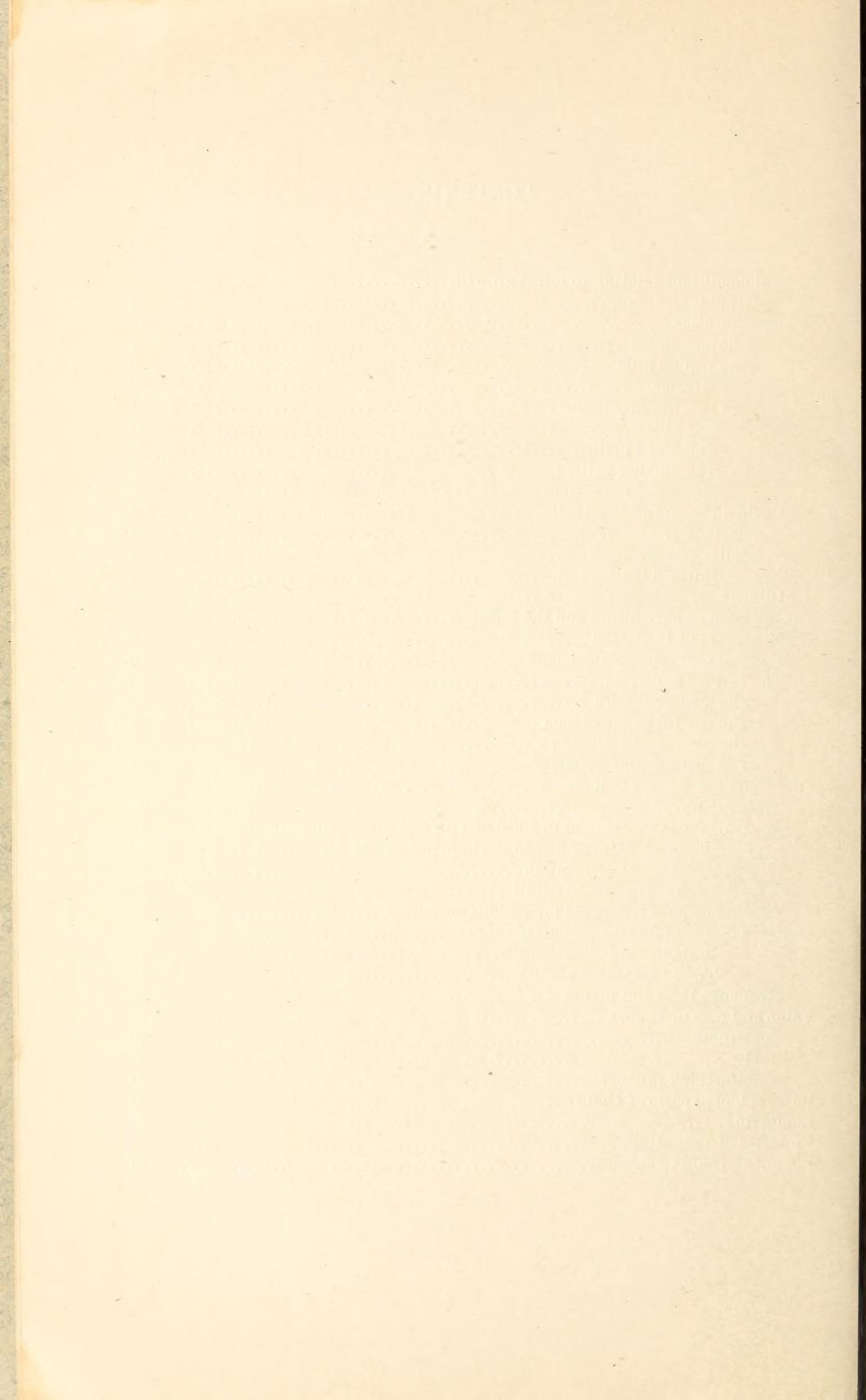
Respectfully,

GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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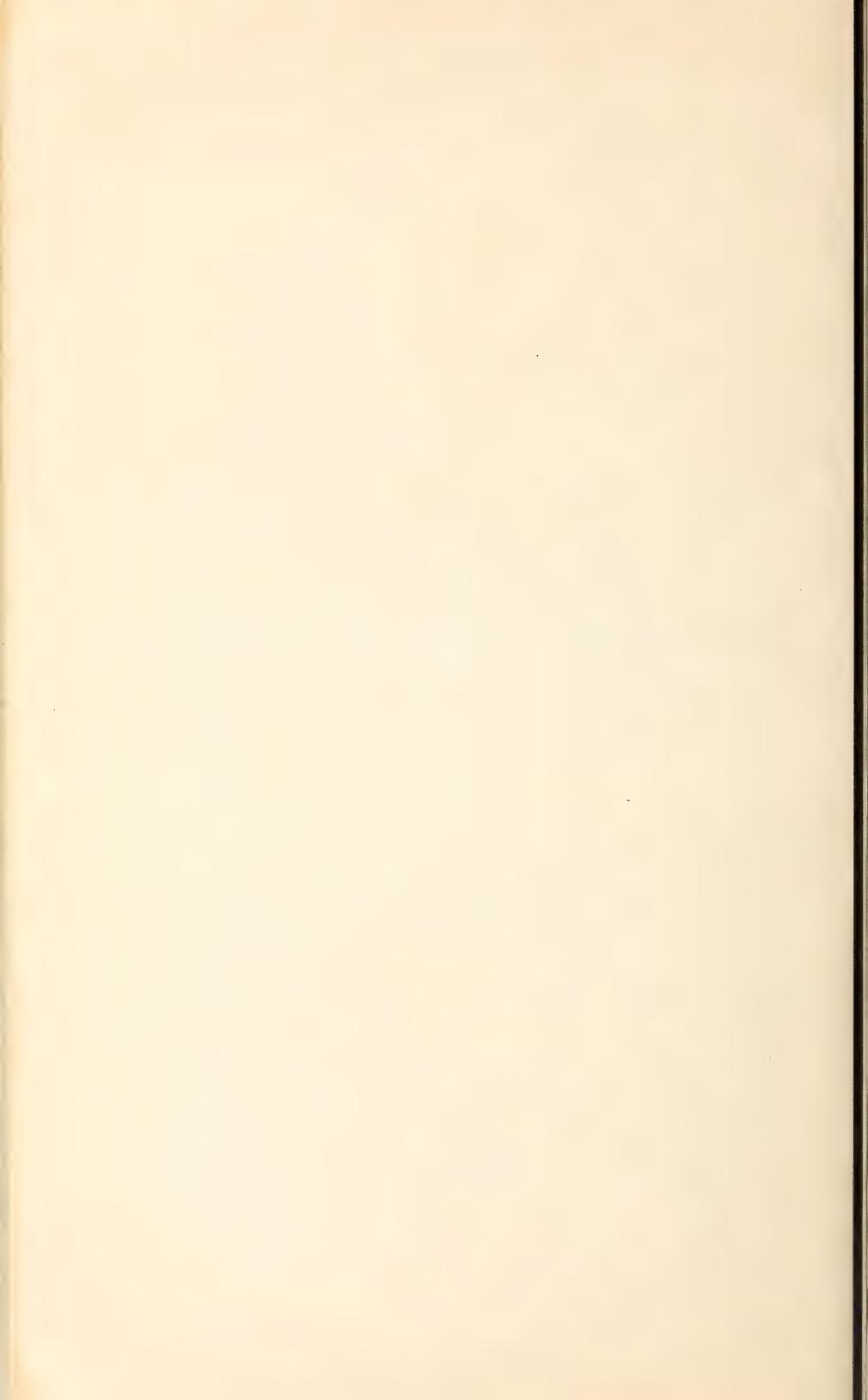
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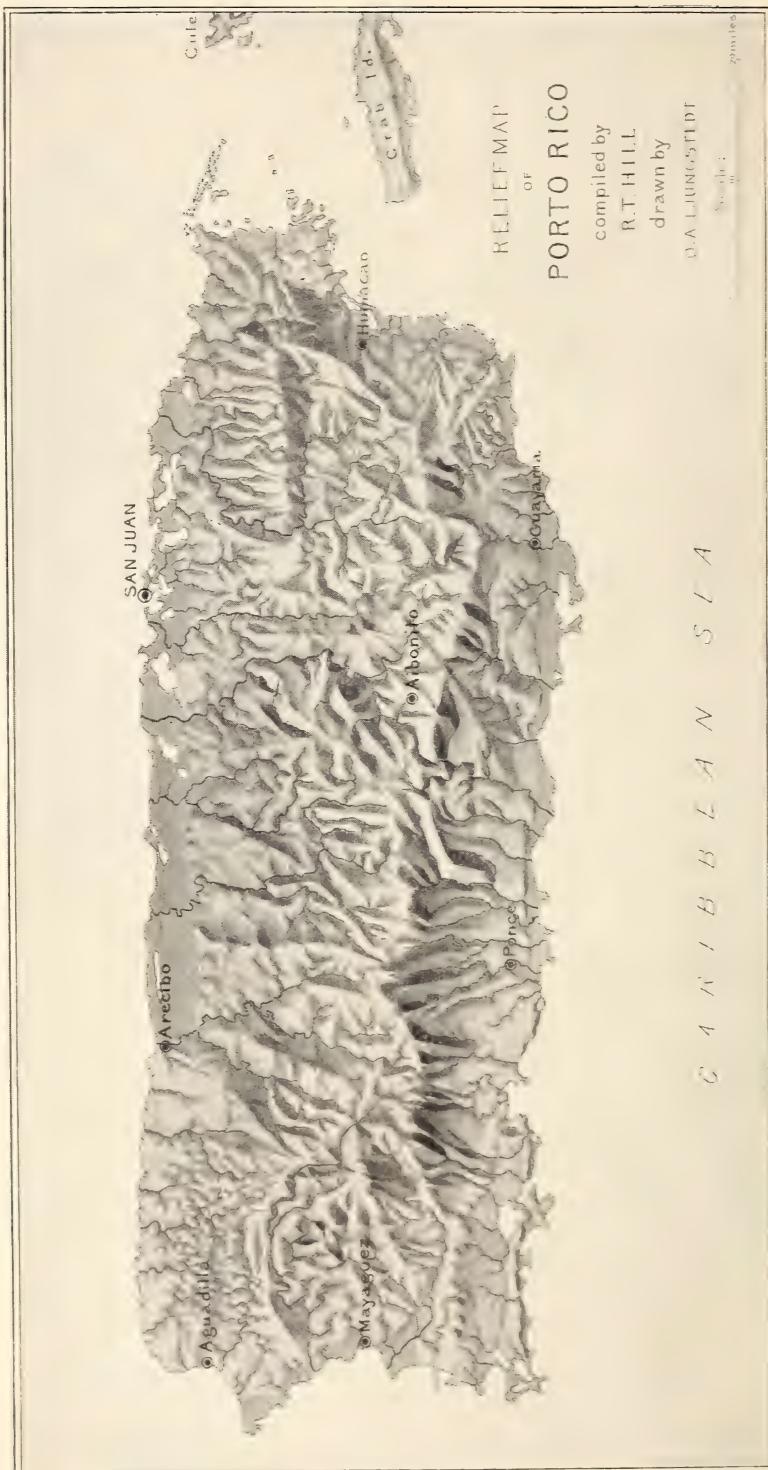
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NOTES ON THE FOREST CONDITIONS OF PORTO RICO.

NATURAL CONDITIONS RELATING TO FOREST GROWTH.

Porto Rico (see map, Pl. I) was originally mantled by forests from the level of the sea to the summit of its mountains. It is doubtful if there was a single foot of its area which was not at some time covered by tree growth, varying in height from the diminutive mangrove bushes which border the seashore, to the gigantic deciduous trees mingled with the fronds and trunks of towering palms, which add height to the loftiest peaks and ridges. To understand the distribution and natural occurrence of these, it is necessary to explain briefly the topographic and physical features of the island.

GEOGRAPHIC SITUATION.

The island is the most eastern and the smallest of the four Great Antilles. Although it nowhere attains the great altitudes of the other Antilles, the island is practically the eastward continuation of the Antillean chain of uplifts, the upward extension of a remarkable submerged mountain slope, which, at least on the north side, descends nearly 30,000 feet to the bottom of the Brownson Deep, until recently supposed to be the deepest hole in the world. The island is 95 miles long, 35 miles wide, and has an area of 3,668 square miles. It is 500 square miles less in area than Jamaica. Its area is 300 miles greater than that of Delaware, Rhode Island, and the District of Columbia combined, and 1,300 square miles less than that of Connecticut. At the same time, in proportion to area, it is of all the Antilles the most productive, the most densely settled, and the most established in its customs and institutions. It is also notable among the West Indian group, because its preponderant population is of the white race, and because it produces food stuffs almost sufficient to supply its inhabitants in addition to its exports to some of the neighboring islands.

Its outline presents the appearance of an almost geometrically regular parallelogram, nearly three times as long as broad, with its sides following the four cardinal directions. The sea line is nearly straight, and the coast is usually low, especially on the southern side, although there are a few headlands. It is void of fringing keys and deep indentations of its coast, such as border Cuba. The coast line is 360 miles.

CONFIGURATION.

Porto Rico, like all the Antilles, in comparison with the United States, has a configuration ancient in aspect, although comparatively new in geologic age. Of the four chief topographic features of the Great Antilles (central mountains, coast-border topography, interior plains, and inclosed mountain basins) only the central mountains and coast-border topography are represented upon this island.

The central mountains are largely of one physiographic type. The coast-border topography is more complex and diversified, consisting of

three subtypes, which may be called coast hills, parting valleys, and playa plains. The mountains constitute the major surface of the island, approximately nine-tenths of the whole. The other features collectively make an irregular and lower lying belt around the coastal margin comparable to the narrow rim of a high-crowned alpine hat. (See fig. 1.)

THE MOUNTAINS.

The whole island is practically an elongated elevated sierra made up mostly of volcanic rock, surrounded by a narrow collar or *dado* of limestone hills, former marginal marine incrustations which have been elevated. Viewed from the sea, these mountains have a rugged and serrated aspect, consisting of numerous peaks and summits with no definite crest line, rising from a general mass whose steeply sloping sides are deeply corrugated by drainageways; they present the aspect of a wrinkled handkerchief—a figure of description ascribed to Columbus in telling Queen Isabella of the Antilles. Their superficie has been etched by erosion into innumerable lateral ridges, separated by deep gorges.

This sculpture is so peculiar to the central mountains of the island that it forms a ready means of differentiating the mountains from the foothills. The mountain region has a long and relatively gentler inclination toward the north coast and falls off more abruptly toward the



FIG. 1.—View of central mountains.

south. While the general axis of uplift extends east and west, the mountains do not now present a well-defined and continuous summit crest, although various terms, like the "central backbone range," are popularly used, indicating such a feature. The chief approach to an axial crest is an irregular line of summits which can be drawn about two-thirds the distance across the island from east to west between the head waters of the streams flowing to the north and to the south coasts. This feature, however, which follows more nearly the southern than the northern coast, is a line of separated peaks and passes. High peaks exceeding in altitude this so called divide project at various places from the lateral ridges which extend between the parallel streams flowing from this drainage divide.

The main crest line extends from Mayaguez on the west through Aibonito and Adjuntas to Humacao on the east. This is called the central Cordillera west of Aibonito and the Sierra de Cayey east of that town. Another eastward extending crest line bifurcates from this main ridge near the center of the island, so that there are virtually two crest lines in the eastern half of the island. The northern branch is the Sierra Luquillo, which practically extends from west of the San Juan-Ponce military road to the northeast cape. This range, which decreases in altitude to the west, contains the highest island summit, El Yunque, and is nearly separated from that of the Sierra de Cayey by the valleys of the Rio Guarabo, which flows west into the Loiza, and the Rio Naguabo, which flows east into the Anegada Passage. The summit lines of the two sierras merge in the vicinity of Barranquitas, near the geographic center of the island. More accurately speaking, these mountains, as a whole, when looked down upon from the highest points, present the aspect of a sea of conical peaks and beaded ridges, rather than a dividing ridge. The highest eminences of the billowy summits nowhere exceed 3,500 feet, and this altitude, if attained at all, is reached by only one peak, that of El Yunque, at the extreme northeast. The height of this peak is given on the Spanish maps at 4,087 feet, but it is reported much lower by other authorities, with a minimum estimate of 3,200 feet. Other summits of the island, although numerous, hardly anywhere exceed 3,000 feet.

THE PEPINO HILLS.

On the west side of the north coast there are some exceptionally high hills which extend back as far as Lares and San Sebastian; they might be considered truly mountainous, owing to their high elevation (1,200 feet) along their interior border, and the fact that they are a part of the general mountain uplift. Along their inner border these are of a remarkably pointed character, known in Jamaica as "cockpits," and are appropriately termed "pepinos," or cucumbers, by the natives of Porto Rico. These are numerous sharp-pointed conical or flattened

limestone hills, the remnants of a dissected *cuesta* or sloping plateau. The interior hills of this group, which are most pointed, rise to 1,200 feet above sea level, although they stand only 300 to 500 feet above the intervening valleys. The extent of this country north of Lares and San Sebastian the writer was unable to determine from personal study, but it apparently stretched below to the northern seacoast.

THE STREAMS.

Through the mountainous mass numerous and copious streams ramify in every direction. (See fig. 2.) These have deep valleys singularly free from cliffs, and they etch the surface into many lateral ridges and points. Of these streams, the largest and longest drain into the north coast, the next largest flow to the west, while the streams of the south and east sides, although copious, are comparatively short. The upper



FIG. 2.—Mountain stream, Sierra Luquillo.

ramifications of the three principal rivers of the north coast reach southward nearly across the island. The most eastern of these is the Loiza, which rises only 8 miles north of Arroyo, on the south coast; the Rio de la Plata, which rises the same distance north of Guayama, and reaches the north coast near the central meridian of the island; the Rio Grande, which rises 12 miles north of Ponce, near Adjuntas, and empties into the sea near Arecibo.

Besides the wide alluvial plains near the mouths of the streams, to be described later, the lower stretches of these northern streams present considerable areas of bottom land, extending for some distances within the margin of the mountain area, rarely broadening out into local circular mountain valleys. Their upper portions are steep angular gorges, however, where habitations are confined to the slopes and not the valleys. There are other streams of the island which also present small areas of bottom land, indenting the mountainous area for a

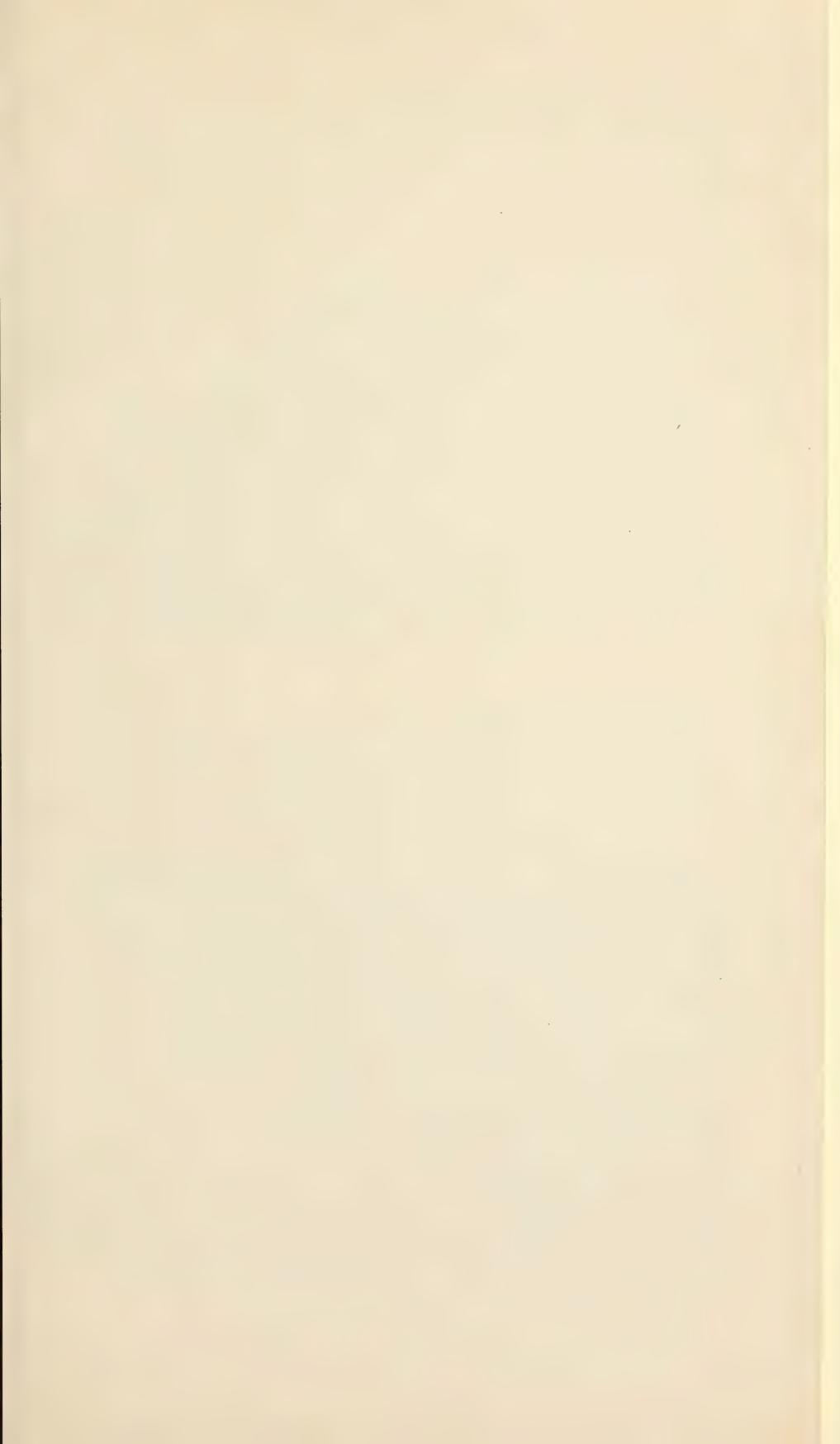




FIG. 1.—VIEW OF SOUTH COAST, SHOWING COAST HILLS, PLAYA PLAINS, AND CENTRAL MOUNTAINS.



FIG. 2.—PLAYA PLAINS AND CEIBA TREE.

very short distance from their coastal borders, notably the Portugues, near Ponce on the south, and the Añasco on the west.

THE COAST-BORDER REGION.

The demarcation between the rugose-angular topography, the soils, and the geologic features of the central mountain regions and the coastal belt is well defined, and the most unobservant traveler remarks the radical natural differences which take place upon passing from the mountains into the lower lying coastal plains and foothills, especially upon the south side.

The coast-border topography comprises a narrow belt of low hills and plains encircling the main or mountainous mass of the island, and broken in continuity upon the northeast, southeast, and west by spurs of the central mountains which run across it into the sea. This border region of itself is an exceedingly diversified area, presenting two conspicuous major types of relief, coast hills, and playa plains, and generally a third type, which may be called parting valleys. (See Pl. II, fig. 1.)

THE HILLS.

Seen from the sea, the coast-border topography at the southwest end presents the aspect of a low tilted dissected bench or plain, bluffing rather abruptly at the water's edge, with its summit gently rising toward the foot of the ribbed and corrugated front of the mountains. Here and there a stream from the mountains cuts across this coast bench and severs it into blocks of hills. The wide alluvial plains of these stream valleys are frequently of a much greater area than the hills. The hills resulting from the dissection of this bench, of whatever shape, either round or oblong, have regular slopes void of the strong vertical corrugations and knife-edged salients which characterize the mountains. These hills are also distinguished from the interior mountains by their entirely different geologic composition, and on the south coast by their vegetation.

On the north the coast hills stand as steeply sloping solitary mounds or domes, rising singly or in chains above wider extents of plain lying between them and the mountain front. The citadels of San Juan are built upon a hill of this character; others rise to the east and west of the city as far as Rio Grande and toward Arecibo. They probably do not exceed 500 feet in height at their interior side toward the mountains, but exact measurements were not made.

Along the shore from the southwest cape of Porto Rico to within 3 or 4 miles of Ponce, except where occasionally broken by playas, coast hills are finely developed. These hills, like those of the north coast, are the remnants of what was once a steeply slanting bench plain. The slant is from the central mountains toward the sea, where the hills are in some places terminated by a steep scarp or sea bluff 100 feet in height. The interior side scarp of these hills is bordered by a valley

occupied by the lake of Guanica, separated by still another row of hills called the cerros from the central mountains.

THE CERROS.—On the southwest end of the island there are two parallel rows of hills separated from each other and the interior mountains by long and fertile valleys. The interior chain of hills, which extends from north of Cabo Rojo to within 3 miles of Yauco, passing west of San German, is of a peculiar type not seen elsewhere on the island. It is a single chain of highly rounded wooded hills of the type called "knobs" in this country, and "cerros" by the Spaniards. They owe their configuration to a thick cap stratum of hard mountain limestone, the lower portion being composed of the softer decomposing rock. Where the cap has been removed erosion has widened the valleys into great elongated plains or vegas.

THE PLAYA PLAINS.

For want of a better, the term "playa plains" is used for the wide alluvial plains found at more or less frequent intervals along the entire coast between the hills which limit them. The word "playa" means literally the shore or strand. Many cities of Porto Rico are situated upon the interior border of such plains where they meet the foothills, several miles from the port of entry, which is located at the immediate seashore, and which is usually designated "playa," in order to distinguish it from the city proper. These playa plains are usually fan-shaped in area, with their broader base next to the sea, where they are often many miles in width, and stand only a few feet above the ocean. They are bordered by escarpments composed of the sharp rise of the coast hills, and extend with constantly decreasing width backward up the stream valleys toward the central mountains.

These plains were formerly old alluvial river estuaries, which in late geologic time constituted bays indenting the land, and have been reclaimed by the general elevation of the island. The playa plains are in many cases so extensive that they now far exceed the area of the limestone bench out of which they were originally carved, and in places the surviving hills of the bench are almost entirely removed.

The playa plains are notably wide along the entire north coast from Arecibo via San Juan to the northeast cape, on the west at the mouth of the Añasco north of Mayaguez and south of the same city (the plain of Hormigueras), and along the south coast east of Ponce. Ponce is situated upon a typical playa plain, which extends a short distance back of the city up the valley of the Rio Portugues. West of Ponce the playa plains are exceptional, the limestone bench being more continuous and less broken in this direction. They are, however, well defined at the mouths of the principal rivers. Similar plains occur at intervals east of Ponce at Salinas, Guayama, Arroyo, and Jacaboa. Extensive playa plains are also met with on the east coast near Naguabo,

Ceiba, and Fajardo, and on the north coast reaching up the valley of the Loiza as far as Carolina (fig. 3).

From San Juan to Camuy, according to Captain Macomb, the railroad follows the south edge of the coast plain, here and there cutting through a little shoulder. The plain is but a narrow strip until close to Arecibo, when a cane country begins, the sea to the left one-half mile or more and the mountains some 4 miles to the south. At Camuy, the railroad terminus from San Juan, the north coast plain is terminated by the rising ground of the pepino hills.

THE PARTING VALLEYS.

The name "parting valley" the writer has given to certain long and narrow valleys which sometimes occur between the foothills and the front of the central mountains. Some of the streams, as they emerge from the mountains and cross the lower country, tend either to bend



FIG. 3.—Rio Loiza, near Carolina.

along the mountain front as they pass from it or to send out laterals parallel to the same. The erosion attendant upon such phenomena produces long parallel valleys at the junction of the mountains and foothills. Parting valleys of this character are especially well developed on the south side of Porto Rico, such as the plain of Saba Grande and the depression of Guanica lagoon. The former is a long valley extending east and west between the cerro and the interior mountains, threaded by the Rio Grande of Mayaguez. This particular valley is almost entirely given up to the extensive cultivation of Indian corn. The latter, separated from the former by the cerros, is the parting valley of the Laguna de Guanica, extending from near Guayanilla to the port of Cabo Rojo. This is a narrow east-and-west valley nearly at sea level, lying between the cerro hills and the narrow rim of coast hills, the latter separating it from the sea. The Laguna de Guanica occupies the east end of this valley, and has outlet to the sea by a narrow passage

cut through the limestone hills. Parting valleys of a similar character are developed in many places around the rest of the island, although perhaps not quite so extensive in area.

MINOR AND EXCEPTIONAL FEATURES OF CONFIGURATION.

Several features which are more developed upon the other Great Antilles are exceptional or lacking in the configuration of Porto Rico—notably, interior mountain valleys, bordering benches of elevated coral reef, the coast lagoons or lakes, and the mangrove swamps. The interior mountain valleys of Porto Rico are not conspicuous features, nor are they completely closed (without drainage outlets), like those of Jamaica, but are local widenings of the stream valleys which formerly reached slack water a considerable distance within the marginal area of the mountain mass, when the present coast bench was submerged beneath the sea. The valley of Caguas is the most conspicuous example of this type. This is a wide amphitheater a considerable distance within the mountain area, and its bottom is filled with old alluvium. It stands at present about 250 feet above the sea.

Elevated reef benches or *seborucco*, which in Cuba form the narrow coast rim of hard rock and protect a softer interior, thereby producing the excellent pouch-shaped harbors, are but faintly developed in Porto Rico. This material was seen only at the entrance of San Juan Harbor, but studies of the littoral were not extensive. San Juan, Jobos, and Guanica, however, are the only pouch-shaped harbors of Porto Rico, and probably their general absence is largely due to the lack of the elevated reef formation. The coast lagoons or lakes are collections of water in swales of the coastal plain on the north and in parting valleys of the type of Guanica, previously described. Mangrove swamps are extensively developed around the interior margin of San Juan Harbor.

GEOLOGIC FORMATION AND SOILS.

In the Southern United States and the Antilles, where altitude is not a controlling factor, the chemical and physical composition of the soils are two of the chief factors producing vegetal differences. Inasmuch as the soils of Porto Rico, with the exception of that of the playa plains, are all residual (the surface decay of the underlying rock), it is impossible to make a clear presentation of the forest conditions without a few remarks upon the nature of the rocks. It is not the intention to go into geologic detail, but inasmuch as all cultural and natural aspects are intimately associated with geologic structure, a few words upon this subject are absolutely essential. Pl. III shows the undergrowth and substructure on the river Brujo.

GEOLOGY.

The mountains are composed largely of black or other dark-colored basic igneous rocks, occurring as tuffs, conglomerates, and silts of



hornblende-andesite, cut by dikes of diorite. While these rocks are of igneous origin, there are nowhere any signs of recent or late eruptive volcanism, such as craters, unburied lava flows, cinder cones, etc., all original volcanic forms of topography having been destroyed by erosion, to which is due the present features of configuration. Besides, much of this volcanic material has been worked over into sediments in prehistoric ages and now occurs in well-defined strata.

Included in this mass of volcanic rocks are two limestone formations, interbedded with them and relatively inconspicuous in area. One of these, found on the crest of the island near Cayey and Aibonito, is a black bituminous shaly limestone interbedded with the volcanic conglomerate. This calcareous horizon, fully 1,000 feet thick, apparently holds the crest of the sierra and weathers into soils noted as the best tobacco lands on the island. The other is a light-gray crystalline limestone with cretaceous fossils (*Rudistes*). It outcrops on an east and west line from near Cabo Rojo to 15 kilometers north of Ponce on the Adjuntas road, and has no special agricultural value, but the natural vegetation is always noticeably different where these rocks occur.

The surface of the upper part of the pepino hills is made up of a rather hard lime marl full of coral heads, with occasional indurated strata of firm white porous limestones. These rocks (the pepino formation) are of Miocene age, as determined by Mr. T. Wayland Vaughan from the corals collected by the writer, similar to certain rocks of Antigua hitherto not known in the geologic sequence of the Great Antilles. Their tilted position, standing at 1,200 feet where they meet the older volcanic mass, testifies to the great geologic movements which have taken place in the West Indies in late geologic time.

Below this limestone, which is at least 100 feet thick, are fossiliferous greensand marls of undetermined age (Eocene or Oligocene), which in turn rest upon a great thickness of thinly stratified reddish lignitic clays and sands of Eocene age (the Richmond formation), which outcrops near San Sebastian, Guatemala, and Mocha on the western end of the island and near Carolina on the northeast coast.

The south coast hills are composed entirely of loose-textured glaring white limestone of a very porous character, often chalky, which was deposited around the margin of the mountainous island mass when it was submerged about 600 feet lower than it stands at present. These are largely of Pleistocene age, although some of the lower strata may be as old as the Oligocene.

The playa plains are composed entirely of alluvium, derived mostly from the mountain formations, but also mixed with the débris of the adjacent white limestone hills.

SOILS.

The chief and radical differences of flora in Porto Rico occur between the red clay mountain soils and the calcareous foothill soils, the latter

being of the open-textured white limestone type which abounds from Florida southward, but is not common in the United States.

The mountain areas present but little if any barren indurated rock surface, but are covered with a deep red soil, to which vegetation clings tenaciously. This mountain soil is one of the most marked features of the island, and to it are largely due many of its agricultural and forest conditions. Were it less tenacious and sticky than it is (and language can hardly convey an idea of the unctuousness of this stickiness, which is especially disagreeable in a road material) the mountain slopes of Porto Rico would now be washed and dreary wastes of barren rock. This mountain soil is mostly red ferruginous clay, accompanied by much pebble and other rock débris. It resembles in color and tenacity the red clay regions of the southern Appalachians, but is derived from quite different rocks, and is apparently much richer in phosphates and lime. These mountain soils are the residuum of the



FIG. 4.—Subsoil and undergrowth in mountain region.

black basic volcanic rocks, the red color being derived from the iron of the latter and the clay from its feldspars. The small patches of hard limestone within the red clay area of the mountain region are usually black, rich, and mellow, and are much more fertile. This is especially notable in the tobacco region around Cayey, which is confined to soils of this character. This soil is naturally ameliorated by the vast amount of humus derived from the native vegetation. (See fig. 4.) Decay is so rapid under perpetual warmth and moisture that the volcanic rocks quickly rot and weather into soils of this character. The regolith or decayed surface of the rocks is unusually deep on these mountains, extending down 50 or 100 feet, correspondingly affording a splendid medium for root hold and penetration.

Owing to this soil the mountains were originally wooded and are now cultivated to their very summits, verticality of slope presenting no obstacle to cultivation in the minds of the natives. The writer has

seen the steepest possible slopes cultivated to the highest degree in coffee and tobacco; in fact, the most productive crops of this character are grown upon declivities upon which the American farmer would not risk limb and life.

The soils of the coast-border region are of two major types: (1) The soil of the limestone foothills; (2) the alluvial soil of the playa plains.

The soils of the foothill region are the residua of the chalky limestones and marls of the substructure, and are excessively calcareous, very much resembling the chalky lime soils of northern Mexico and the Rio Grande region of Texas. On the wet north side, where there is more moisture, the limestones are more decayed and the regolith is deeper, the resultant soils being a red residual calcareous clay from which the excess of lime has largely been removed by solution, although lumps of undecomposed coral limestone remain. On the south the regolith is shallow and the soils are correspondingly thin. Furthermore, they contain an excessive proportion of lime. In places, notably near Guayanilla, these hill soils are less than a foot in depth, and are underlaid by incrustations of the peculiar calcareous pan known in Mexico as "tepetate." These chemical, physical, and climatic differences produce a more stunted arborescent growth than the red clays of the mountain region. At least, the vegetation is dwarfed and largely made up of different species. The limestone hills are mostly grazing lands. The soils of the white limestone districts of the pepino hills are of a different type from those of the hills of the coast-border region. Those of the pepino hills are in general of a marly character, whitish below and black in the exterior. Upon the hilltops they are thin and unproductive, but where gathered into local valleys they are deep and rich, and are considered among the most productive on the island.

The soil of the playa plain is purely alluvial, usually consisting of a rich, red loam. These extensive alluvial deposits combine essentially the qualities of the residual soils, both of the clay mountains and the calcareous foothills, with the additional advantage of a more loamy physical structure adapted for better drainage and root penetration and general cultivation. In the northwest portion of the island, where the alluvium is principally derived from the calcareous pepino hills, the soils are blacker and more calcareous. These soils constitute the sugar lands, and Porto Rico's sugar-producing capacity can be measured by their areal extent.

RUINATE LANDS.

Much of the soil of Porto Rico is now abandoned and in the condition known throughout the English-speaking West Indies as "ruinate." This has resulted from long cultivation, from the failure to apply fertilizers, and, in some cases, from erosion. Land of this character was observed in many parts of the island. On the north coast, in the

vicinity of Rio Grande and Carolina, ruins were seen of what were once houses of extensive sugar estates, the former fields being grown up in grass. In the western part of the island, in the high summit region, seen in passing from Adjuntas to Lares, many abandoned fields were observed, which are now entirely denuded of trees and cultivated crops. Considerable areas of ruin are also observed on the south coast, between Juana Diaz and Ponce. The reclamation of these lands by forestry or the methods of scientific agriculture is one of the problems which Porto Rico presents to the civilization of its new owners.

CLIMATE.

The climate of Porto Rico has been recently studied upon the ground by Prof. Mark W. Harrington, of the U. S. Weather Bureau, and no attempt will be made to describe it other than to state a few facts relating to its bearing upon the distribution of life and culture. Professor Harrington has already published many new and interesting data concerning the climate and its local variation, which will be found in the publications of the U. S. Weather Bureau.

The whole island may be divided into a wet and a dry belt, on the north and south sides of the central Cordillera, respectively. The greatest rainfall, which sometimes attains 120 inches a year on the slopes of El Yunque, is at the northeast end. On the south side, from Guayama to Cabo Rojo, the climate is dryer, but most of the island is wet in comparison with the standard of the United States. The higher mountains are slightly cooler than the coast belt, but the temperature is so uniformly warm that altitude has but little bearing upon distribution of vegetation. The mountains are constantly bathed in moisture, either by daily rainfalls or dense mists which collect upon them at night, except upon the lower portion of their southern slopes; hence, it may be said that the surface is never dry and the subsoil is constantly saturated in the mountain region.

On the southern coast, however, owing both to the porosity of the limestone, which quickly drains off the moisture, and to the intermittent dryer periods, the surface above has a parched and arid look, especially in the long dry season. Some portions of this south belt are very arid, and great complaint was heard in places that the rainfall for the past two years had been insufficient for domestic supply. In fact, to cultivate the staple crops of the lowlands of the south coast, irrigation is necessary. This is practiced with great skill and at considerable cost along the whole southern border from Guayama to Cabo Rojo.

THE RELATIONS OF AGRICULTURE AND THE FOREST.

Porto Rico is densely populated, and the whole area, with the exception of probably less than 1 per cent, is or has been devoted to either agricultural or pastoral pursuits. The three staple agricultural products of the island are sugar, coffee, and tobacco. While these constitute

the export crops, they do not occupy one-half the cultivated land, the remainder being devoted to the growing of small products for domestic consumption known as "menores." The pasturage lands are extensive.

Of the staple export crops, sugar is grown exclusively in the playa plains or their alluvial extensions for a short distance up the stream-ways into the mountain regions. The cultivation of this product necessitates the complete clearance of timber from the soil, and hence the land so occupied may be eliminated from the forest problem. At the last census (1888) there were 433 sugar estates upon the island. The sugar lands of the island are fully occupied.

The best coffee and tobacco are grown upon the soils of the interior mountains. The export coffee requires strong rich soils and is cultivated to the very mountain summits; the higher the altitude the better the quality in Porto Rico. The total acreage in coffee can not be stated, but the latest figures obtainable show that there were 361 large coffee estates and 4,184 small coffee farms. The cultivation of this crop requires shade, and both natural and planted trees are employed for this purpose, giving to the coffee plantations a forested aspect. Coffee culture is also very exhaustive to the soil, and as a result, while there may be a large suitable acreage unoccupied by plantations, there are many which have been cultivated for this crop and abandoned. Land thus disused goes slowly back to tropical vegetation, but the process of natural vegetal reclamation is so slow, owing to the exhausted condition of the soil, that its former use is long evident.

The best tobacco is cultivated upon the mountains, notably in the vicinity of Cayey. The cultivation of this crop requires complete deforestation, and, like coffee, is exhaustive to the soil. When abandoned the land grows up in grass, and trees seem loath to reoccupy it.

In addition to the coffee and tobacco plantations there are nearly 22,000 small farms in Porto Rico devoted to small fruits and miscellaneous cultivation, and these naturally occupy a large area of its surface and result in the destruction of the native forests.

Cattle are raised everywhere upon the ruinate estates in the mountains and principally on the chaparral-covered hills of the coast border region. At the last census there were 240 farms devoted exclusively to the growing of cattle.

In all there are 26,650 farms in Porto Rico, or nearly 7.4 farms to the square mile. This intensive culture, continued for a long time, has been destructive to the natural vegetation.

FOREST ASPECTS OF THE ISLAND.

Those who have read Kingsley's interesting description of the tropical forests of Trinidad or Lafcadio Hearn's vivid pictures of the vast woods of Martinique will be disappointed not to find such forests and woods duplicated in Porto Rico, except in the single instance of the

summit portion of El Yunque, in the Sierra Luquillo, where there are about 8 square miles of virgin forest. The island, although wooded in the sense that it is still dotted by many beautiful trees, is largely deforested from a commercial point of view. Porto Rico, at the time of its discovery, was undoubtedly completely covered by forests of many species of trees, but these can hardly be said to exist at present. A few insignificant patches of celled forest also occur in the central and northwestern portions of the island, which will be described presently. (See Pl. IV.)

WOODED CHARACTER OF THE ISLAND.

To the casual observer, the aspect of Porto Rico in places is still that of an open wooded landscape. The farms and plantations, excepting the tobacco and sugar fields, are not cleanly cleared like those of the United States, but, on the contrary, individual trees are abundant



FIG. 5.—Wooded mountains, Sierra Luquillo.

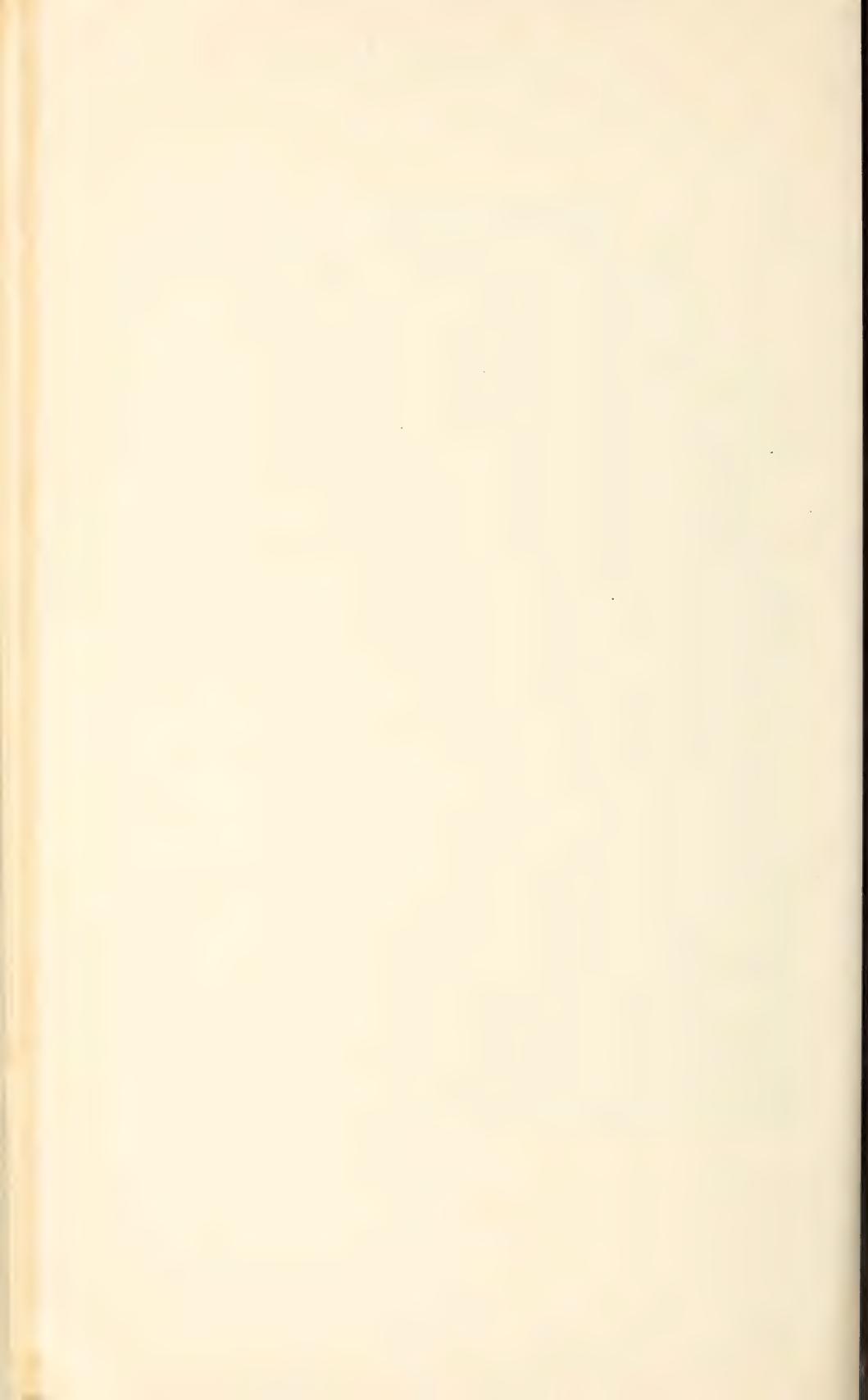
and well distributed everywhere. (See Pl. V.) Along the roadsides, around every hut, and throughout the coffee plantations are many trees, a few of which are remnants of the aboriginal forest, while most of them have been planted for shade or fruit. Orange trees, mangoes, aguacates, breadfruit, mameys, and other stately trees are common, while, as in our own deforested region, there are a few timber-making trees which have been spared the ax. Besides these larger trees, flamboyantes, nisperos, and guanabonas of smaller growth add their foliage to the wooded aspect of the island. (See fig. 5.)

THE VARIOUS FLORAS.

So far as was observed by reconnoissance methods the island presents two strongly marked and contrasting zones of vegetation. One includes the whole of the mountains and north coast region and the other is the foothill country of the south coast. The first is a region of great and



DEFORESTED MOUNTAIN SOUTH OF AIBONITO.



constant humidity, high altitudes, and stiff clay soils; the other a region of dry calcareous soils, seasonal aridity, and low altitude. The transition between these vegetal zones is very abrupt and immediately noticeable as soon as one passes from one of these regions to the other. It is true that the rainfall is less on the south coast and the country in general more arid, but there is also an immense difference in the capacity of the two geologic soils for retaining moisture and for root penetration, the clay soils being always saturated, while the limestones are porous and dry.

THE MOUNTAIN FLORA.

The climate of Porto Rico, although in general warm and humid, has a milder temperature and a greater constancy of moisture on the highlands than in the lowlands, while upon the latter there are occasional



FIG. 6.—South coast undergrowth, with central mountains in distance.

periods of drought. Accordingly, the mountains are constantly clad with fresh green verdure (consisting of such remnants of the primitive flora as have escaped the destruction of man) and cultivated trees, while the flora of the border region has at times a dry and yellow aspect.

THE MOUNTAIN WOODLANDS.

The general growth of the mountain region consists of deciduous trees of many species, freely intermingled with shrub and grass, and above 1,000 feet with tree ferns. In some places the undergrowth is made up largely of ferns of numerous species, many of which are so tall and dense of growth as to constitute a veritable jungle. (See fig. 6.)

Much of the mountain landscape is now occupied by cultivated crops of coffee, tobacco, fruit trees, shrubs, etc., broken by verdant pastures of tall Para and Guinea grass, which constitute the staple forage of the island. There are many large cultivated shrubs and bushes, attaining the size of a peach tree, which give an aspect of primeval wildness

to one who first sees the country: hence, it is that some of these mountainous portions of the island which have the aspect of thick primeval forests, when first viewed from a distance by the traveler from the temperate climes, are really the most highly cultivated.

Such wooded lands are often occupied by the coffee plantations. The coffee bush, which attains no great height, is always accompanied by an overgrowth of dense shade (the first essential to the life of the coffee bush), so that the latter has the appearance of an underbrush in the midst of high forest trees. The writer has often found it difficult to convince a fellow-traveler that he was in a coffee plantation and not a jungle, until a tree could be found full of the bright red berries which distinguish the coffee plant. In fact, a Porto Rican coffee plantation, with its accompanying shade trees, is an artificial forest.

In preparing a coffee plantation, the native forest is either thinned of all except the highest trees or completely cleared of all growth and new trees planted for the express purpose of affording shade. In the latter case the shade trees are planted at the same time as coffee, and hence are an integral part of the general culture. The trees thus used are the guava,¹ guama, bucare, and maga. These are trees which grow so rapidly that, by the time the coffee bush reaches maturity at the end of seven years, they are very tall forest trees, giving a dense shade above the bush.

The mountain trees are of many genera. They are largely hard-woods, occurring singly or in varied association, and not as collections of a single species, such as the pine forests of the United States. Among the trees of the mountains may be mentioned the following:² Papaya, guayacan, bucare, tabanuco, cañafistolo, maria, guama, guava, pimenta, nutmeg, sabino (talaumo), hirtella, guava, lobelia sp., heliconia sp., ausubo, guaraguao, maga, laurel, capa, cedro, cojoba, roble, ceiba, and several palms.

THE FOREST OF EL YUNQUE.

Single specimens or small groups of the above trees, which have been spared the woodman's ax (see fig. 7), may be found throughout the upland portion of the island. In one place, however, the original forest has been preserved. This forest is upon the summit of El Yunque, the highest peak of the island, situated near the northeast end, and has been protected by its inaccessibility. Although the mountain is hardly over 3,200 feet in altitude, it is constantly bathed in moisture, and the steep trails to its summit through red clay and mud are almost

¹*Inga vera*. The guava tree of Porto Rico is not to be confused with the guayava bush. The former is a tall tree; the latter is the bush which is called guava in English.

²In Porto Rico native names are given to most of the trees; these names are largely used throughout the report. The botanical names of these trees are given on the last page of this bulletin.

impassable for man and beast. The forests on El Yunque consist of an almost impenetrable jungle of trees, underbrush, and lianas, and are exceedingly wet, the rainfall averaging 120 inches per year.

The following interesting description of some of the trees of the

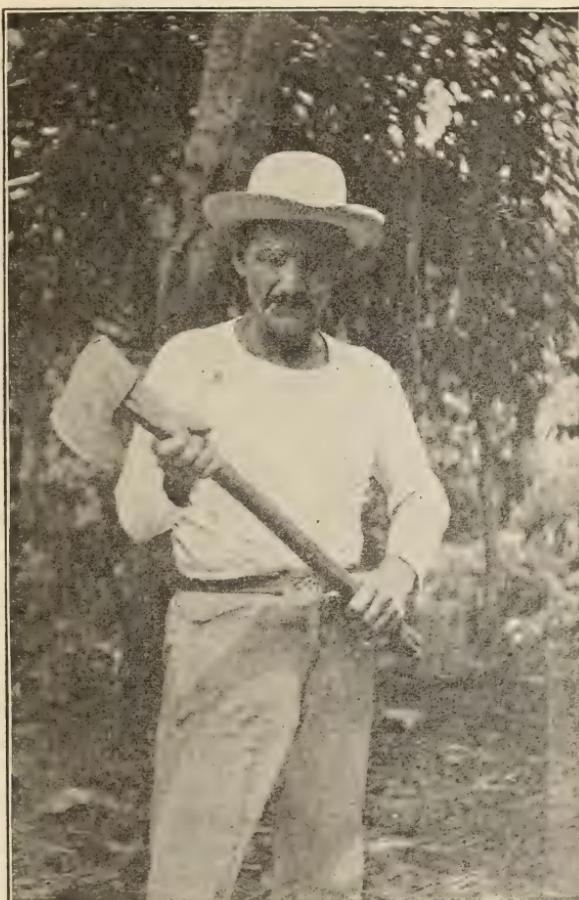


FIG. 7.—Woodman with ax.

primeval forest of El Yunque has been given by Dr. George Eggers, the only botanist who has studied it, in a letter written to Sir Joseph Hooker in 1883:¹

* * * Have at last accomplished my long-cherished design of exploring the Luquillo Mountains in Porto Rico, which island I visited during April and May this year. I spent about five weeks there, living for some time in the hut of a gibaro, or native laborer, on the sierra, at an altitude of about 2,200 feet, on the edge of the primeval forests that still cover all the higher part of the mountain range.

As for the general character of the Sierra Yunque forests, they of course resemble in their main outlines those of the other West India Islands. There is, however,

¹ See "Nature," London, 1884, Vol. XIX, page 129.

especially one feature that strikes me as being peculiar to this mountain ridge compared with the woods of other islands, for example, of Dominica. While the climate is just as moist in the sierra of Porto Rico as in that of Dominica, the forests of Porto Rico seem nearly entirely *destitute of epiphytes*,¹ with the exception of some few Bromeliads and a very rarely occurring stray orchid. But orchids in general and epiphytical ferns, such as *Trichomanes* and *Hymenophyllum*, etc., are conspicuous by their absence. Of palms, I found but one species, which I have distributed in my "Flora." I believe it is a *Euterpe*; grows gregariously at an altitude from 1,500 to 3,000 feet. No Cycads were seen at all.

On the other hand, I found several interesting trees, especially a beautiful *Talauma*, with immense white, odorous flowers and silvery leaves, which would be very ornamental. The wood is used for timber, and called *Sabino*. A *Hirtella*, with crimson flowers, I also found rather common. It is not described in any of the Grisebach's publications. An unknown tree, with beautiful, orange-like foliage and large, purple flowers, very similar in shape to those of *Scarola plumieri*, split along one side, a tall *Lobeliacea*, a large *Heliconia*, nearly allied, it seems, to *H. caribaea* Lam., and several other as yet undetermined trees and shrubs are among the most remarkable things found.

On the whole, I was somewhat disappointed with regard to the result of the voyage, as I had expected a greater number of novelties, as well as a richer vegetation in general, at least something like the Caribbean Islands. But these partly negative results may no doubt be of some value also in forming an idea of the West Indian flora in general. Of tree ferns, *Cyathea*, *Serra*, and an *Alsophila* were not uncommon.

One of the most conspicuous trees in some parts is the *Coccoloba*² *macrophylla*, which I found on my first visit to Porto Rico. This tree is found up to an altitude of 2,000 feet, but chiefly near the coast, where it forms extensive woods in some places, which at the time of flowering, with immense purple spikes more than a yard long, are very striking. The tree is named *Ortegon* by the inhabitants. It does not seem to occur on any of the British islands, but to be confined to Porto Rico and Haiti; at least I do not see it mentioned in Grisebach's Cat. Plant. cubensium.

Logs are still cut from the edge of the Yunque forest, but the cost in time and labor of securing timber therefrom is far more than it would be to import similar woods from Santo Domingo.

A few acres of forest are also preserved here and there in the Sierra Cayey and the Cordillera Central, notably between Aibonito and Adjuntas. Collectively, these small patches will not aggregate 10 square miles of standing timber, and have been largely culled of their most valuable trees. There is also a small patch of forest preserved in the pepino hills, near Aguadilla, upon a small piece of land belonging to the Government. There may be a few more acres elsewhere. Otherwise, in a commercial sense, the mountains are deforested, although some excellent trees still stand, just as walnut trees are found preserved in the deforested areas of the United States.

THE COAST-BORDER WOODLANDS.

The second class of flora inhabits the foothills belt lying between the southern front of the Central Mountains and the southern coast, a region which is comparatively arid. The wide playa plains and stream

¹ In this Mr. Eggers is mistaken; *epiphytes* abound in some other parts of the island.

² Misprint of *Coccoloba*.

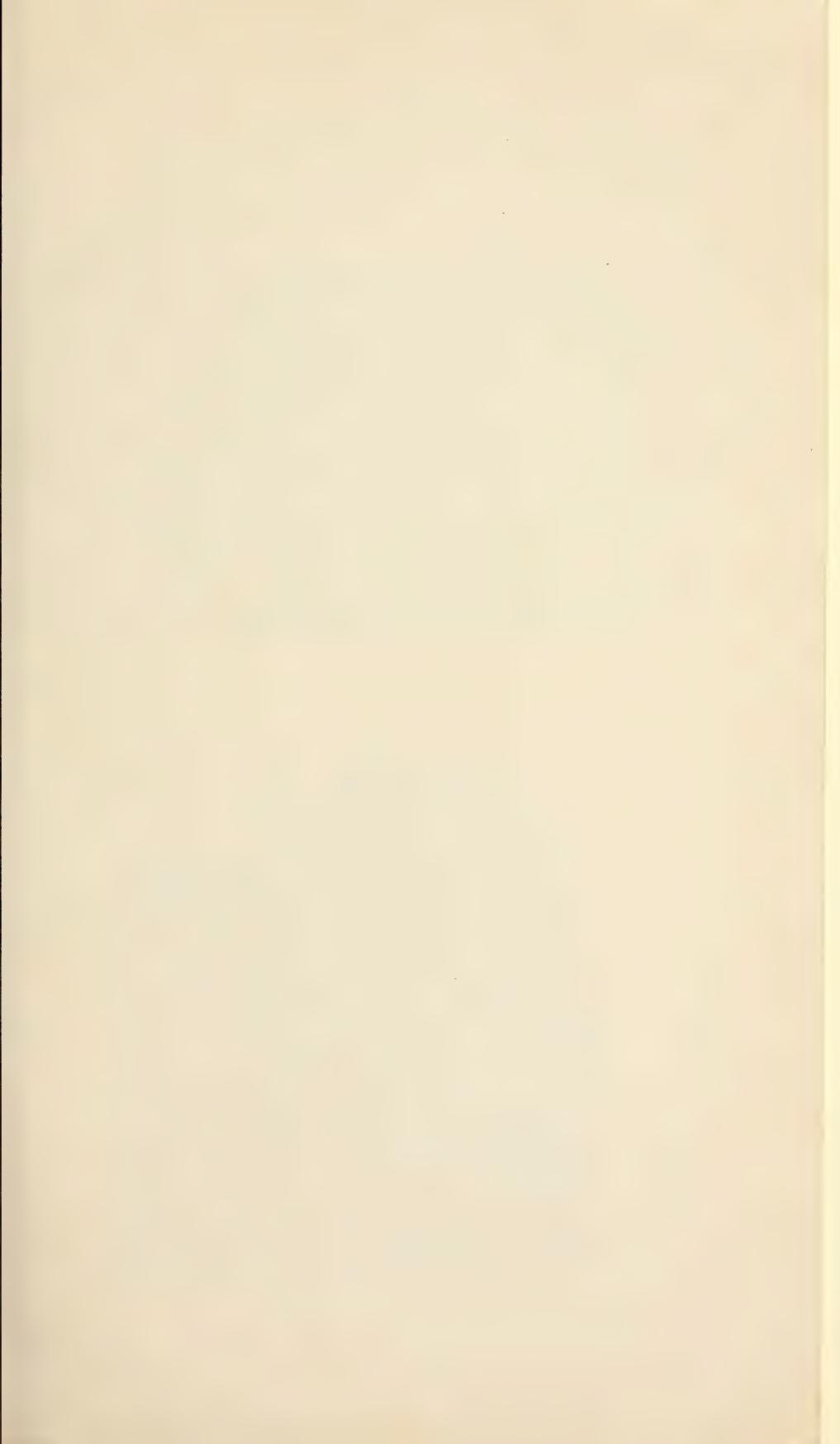




FIG. 1.—A PLAYA PLAIN WITH MANGO TREES. (COAST HILLS IN BACKGROUND.)



FIG. 2.—PALM TREE.

valleys of this belt were also once covered with large trees, a few scattered examples of which have been preserved, but in general these have been destroyed in order to clear the land for sugar culture. (See Pl. V.)

This flora is markedly different from that of the mountain region, although there are a few species of trees common to both regions. It is largely of the type of low, shrubby, thorny, leguminous, and acacia-like trees, with compound leaves and thorny trunks or stems covered by *Tillandsia* (Spanish moss), and largely of the type of growth known in the United States as the chaparral. In the dry season this flora produces a brownish landscape, as distinguished from the evergreen of the mountain region. This chaparral-like flora is thorny and dense, especially on the coast hills between Ponce and Yauco. In this region it is accompanied by a thick undergrowth of grass, and, with the rolling hills and "tepetate" soil, repeats nearly every aspect of the Lower Rio Grande country of Texas.

The limestone summits of the hills, or cerros, west of Yauco are covered by a remarkable growth of chaparral, including tree cactus, among which are organ-pipe forms resembling those of the California deserts and the tree opuntias of Mexico, accompanied by thorny brush, the whole draped by the epiphytic moss (*Tillandsia*).

Besides the common fruit trees, the most conspicuous trees of the coast-border region are: Algarroba, bixia, ceiba, wax tree, higuereta, tamarind, manzanillo, nutmeg, *Coccoloba macrophylla*, ausubo, flamboyant.

Among the trees which grow in both regions are the guanabanos, the tamarind, the cañafistolo, or senna, and the ceiba. (See Pl. II, fig. 2.)

FOREST AND OTHER TREE PRODUCTS.

The products of the forests and other vegetation of Porto Rico are numerous, although of no great export value. They are of greatest importance to the inhabitants of the island, as will be shown later.

TREES USED BY MAN.

Among the products of the forest the following trees are used by man:

FOR TIMBER AND FUEL.—Algarroba, ausubo, capa blanca, capa prieta, laurel sabino, laurel blanca, guayacan, uear (ucare or jucare), espejuelo, moca, maricao, mauricio, ortegon, tachuelo, cedro, cojoba, aceitillo, guaraguao, maga, yaiti, palo santo, tortugillo, zerreuela, guayarote, higuereta, tabanuco, mora, hueso, hachuelo, "ileucedran."¹

¹ The names of the woods here given are as they were written by the native Porto Ricans who assisted in their collection, and as they are spelled in the Commercial Directory of Porto Rico. There are some peculiar disagreements of gender which the writer can not explain. The writer has also been unable to find any mention of "ileucedran" in print, and the name may be erroneous.

FOR CORDAGE.—Mahagua, a tall malvaceous bush.

FOR DYEING AND TANNING.—Moca, brasilete, achiote, granadillo, maricao, dividivi, mora, gengibrillo, camasey, vijao, mangle.

RESINOUS TREES.—Tabanuco, pajuilo, algarrobo, mamey, masa, cupey, maria, guayaco.

FOREST TREES YIELDING FRUITS.—Piña, níspero (medlar tree), mangó, guanabana, cocotero, aguacate, naranjo, jácana, mamey, wild orange.

EXOGENOUS WOODS USED IN CONSTRUCTION AND OTHER INDUSTRIES.

The writer, during his stay upon the island, collected sixteen specimens of the native woods which are utilized by the people in construction and other industries. Fifteen of the woods are shown upon Pls. VI, VII, VIII, the figures of which are printed directly from the woods themselves. The descriptions of the woods are by Mr. George B. Sudworth, Dendrologist of the Division of Forestry.

CHARACTERISTICS OF FIFTEEN PORTO RICAN WOODS.

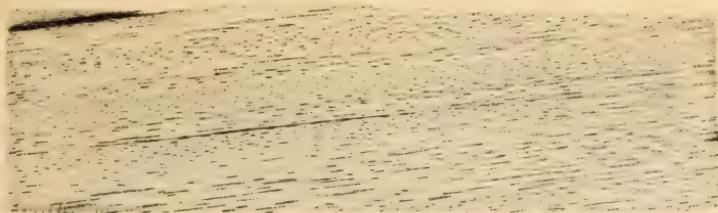
General description.

Of the fifteen samples of Porto Rican woods examined, nine of them, namely, mora, guayacan, hueso, ausubo, ucare negro, pata de caba, ucare blanca, hachuelo, and algarrobo, were found to be very hard, close grained, and heavy. The samples of equal size and of approximately the same condition vary but little in weight and are remarkably similar in hardness. The following table shows the comparative weight of the nine samples:

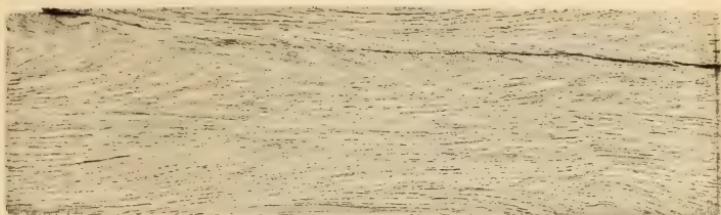
Comparative weight of nine samples of Porto Rican woods.

Name of wood.	Weight per cubic foot.
	Pounds.
Mora	61.8
Guayacan	76.8
Hueso	60.0
Ausubo.....	70.2
Ucare negro	64.2
Pata de caba	60.0
Ucare blanca	61.8
Hachuelo	70.2
Algarrobo	64.2

Extreme density is shown by small pores (ducts) and in numerous, minute, mostly continuous medullary rays, imperceptible to the naked eye. The main structure is made up of thick-walled cells. The annual layers of growth are small and comparatively indistinct, owing to the irregular diffusion of the large ducts, which in most northern woods



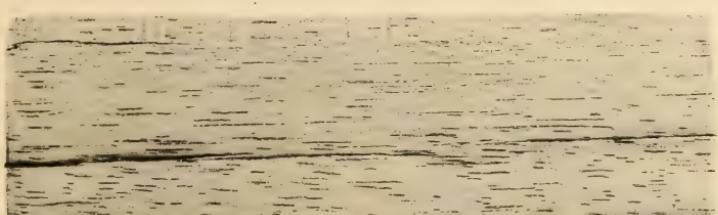
MORA



HUESO



UCARE BLANCA

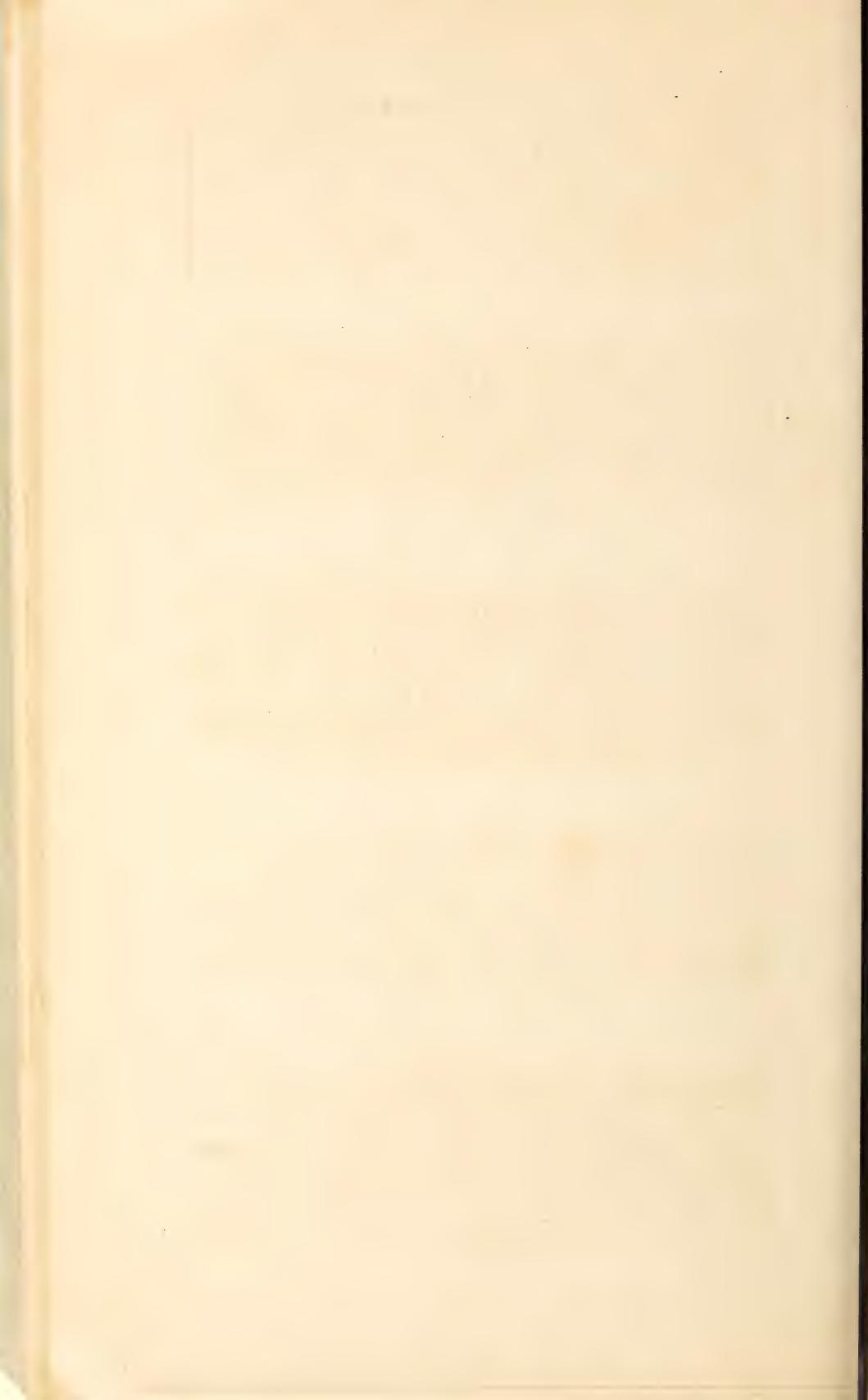


MAGA



UCARE NEGRO

WOODS OF PORTO RICO.

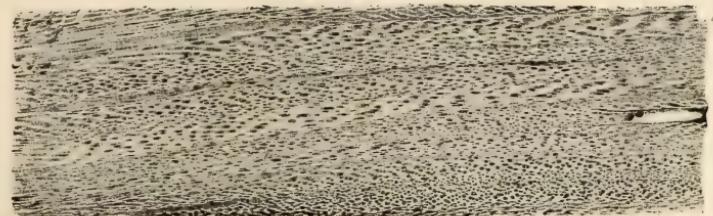




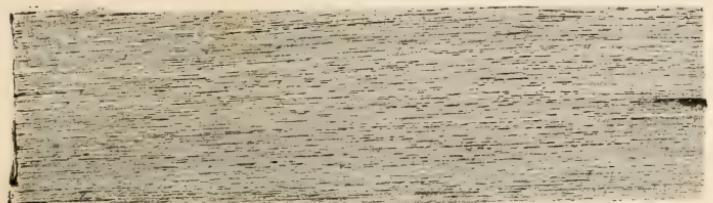
LAUREL SABINO



CEDRO



LEUCEDRAN

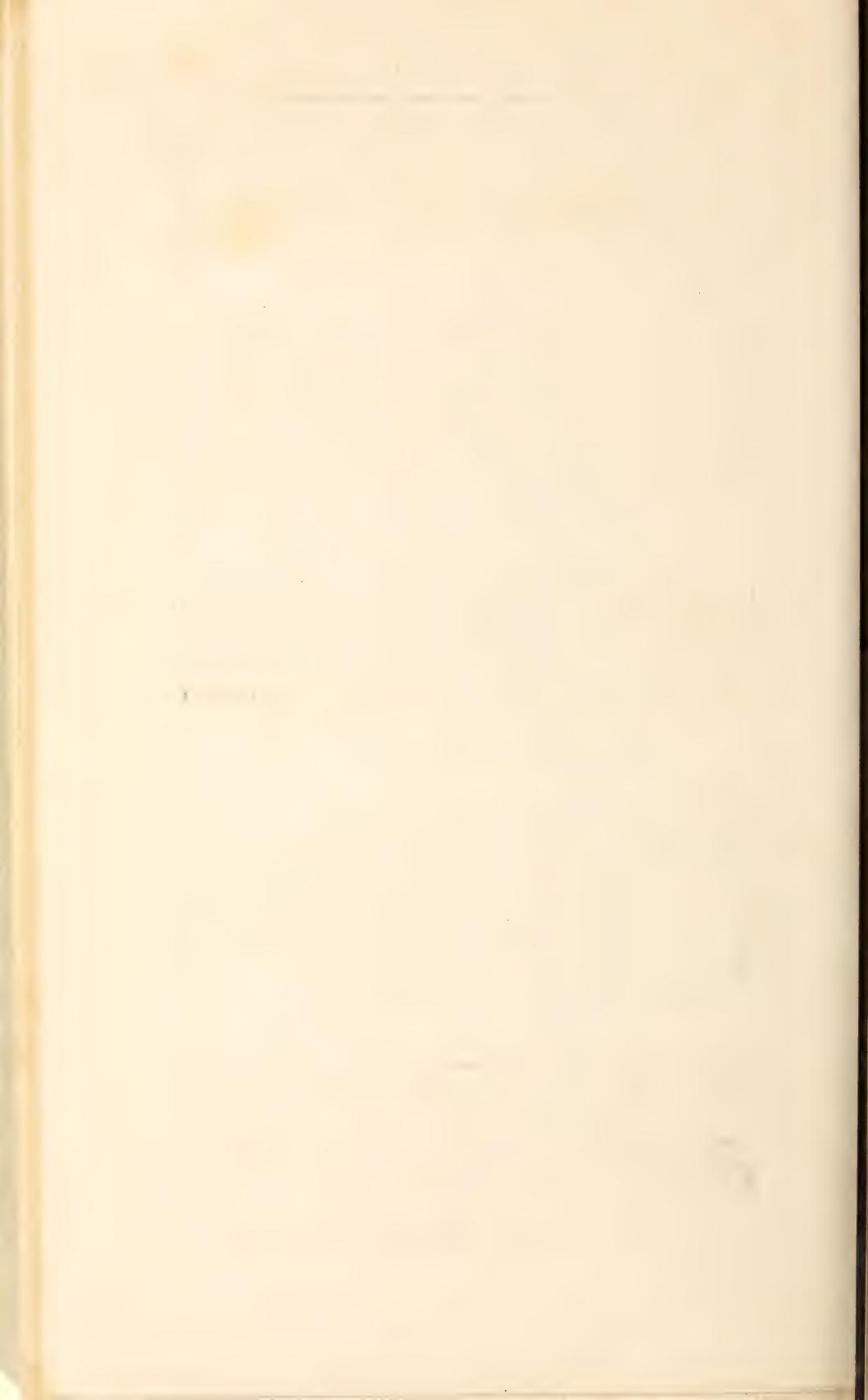


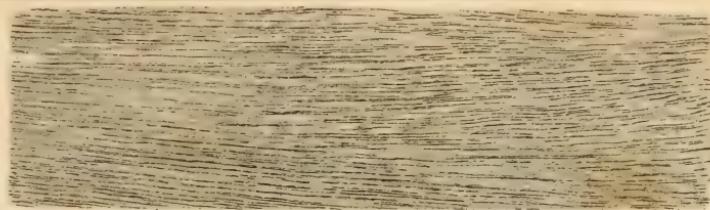
CAPA BLANCA



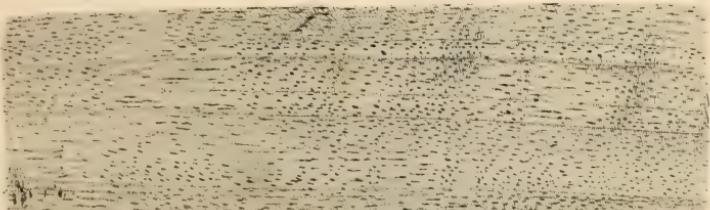
CAPA PRIETA

WOODS OF PORTO RICO.





AUSUBO



PATA DE CABA



GUAYACAN

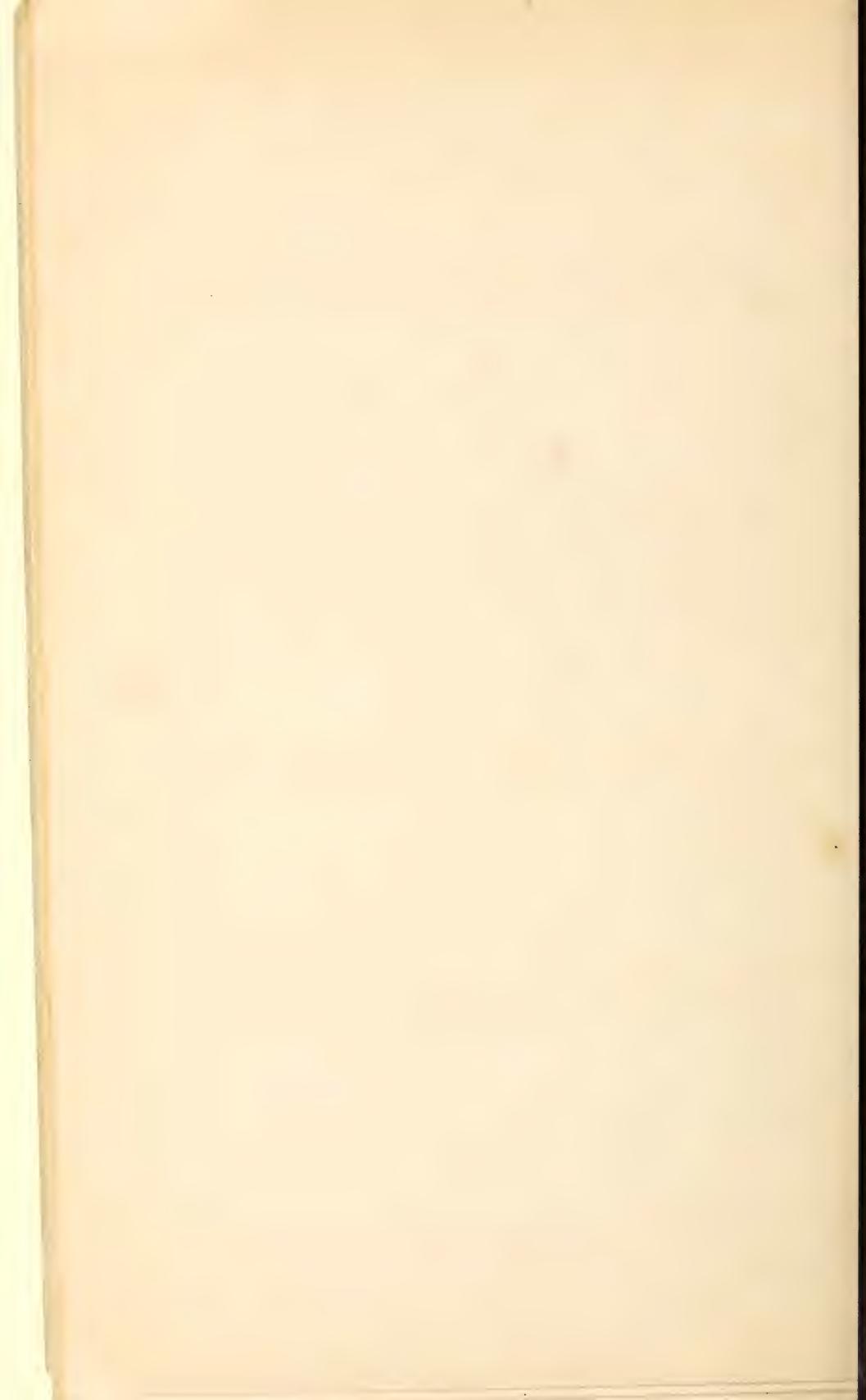


HACHUELO



ALGARROBO

WOODS OF PORTO RICO.



clearly mark the layers of growth. The wood fibers are strongly interlaced ("crossgrained"), giving a "tough," uncleavable character to the wood.

The samples of mora, guayacan, hueso, and ucare blanca show a tendency to check and warp in seasoning, while ausubo, ucare negro, pata de caba, hachuelo, and algarrobo appear to maintain good form in drying out. The injury from checking of the former is, however, not great, and appears not to impair the usefulness of these woods for certain purposes. All are capable of receiving a high polish and require but little "filling."

Ausubo, ucare negro, pata de caba, hachuelo, and algarrobo are eminently cabinet woods of great value and attractiveness, mora and ucare blanca are less attractive for this purpose, but may have limited use. Guayacan and ausubo are especially adapted for small turnery, tool-handles, etc., where great hardness and wearing qualities are needed. Pata de caba and algarrobo closely resemble the rosewoods of commerce. With a permanent black stain, ucare negro and hachuelo are useful substitutes for ebony. Ausubo is similar in appearance and a good substitute for the valuable "coccobola" (*coccoloba*), so much imitated by inferior woods.

Laurel sabino, cedro, capa blanca, capa prieta, guaraguao, and maga are characteristically lighter, softer, and coarser grained than the nine species above mentioned. The weight of these samples varies but little, the average being 38 pounds per cubic foot.

With the exception of laurel sabino, all are attractive in grain and suitable for finishing woods.

Description in detail.

The following descriptions give the specific characters of the various samples:

MORA.—Color, bright orange-brown, probably darkening with age and exposure. Marked on the radial section with parallel light and dark streaks. Large ducts arranged in wavy, irregular lines; lines also irregularly broken into crescent-shaped groups. Medullary rays distinct, rather coarse. Radially cut and polished surface satiny. Similar in general appearance to osage orange. Largely used for fellies.

GUAYACAN.—Heartwood dull yellowish-brown, with dark olive-brown streaks; sapwood pale yellow, with brownish areas. Minute ducts occurring singly and evenly scattered. Medullary rays very small and indistinct. Smoothed surface, oily to the touch. Exceedingly hard, brittle, and difficult to cut. Resembles *Guajacum officinale*, and is probably *G. sanctum*. It grows in comparative abundance in the entire mountain chain and on the southern coast of the island, producing a wood which is very solid and resistant. On this account it is much sought after in the shipyards for blocks and pulleys, for spokes and tires, and many other things which require great

strength. Water boiled with this wood is an antivenereal specific and cures ulcers produced by this disease. The resin from the guayacan *lignum vitae* is highly valued for gout. The Caribbeans apply it to other local ailments, and foreigners extract it freely on the southern coast, equally with the *ucar*, *espinillo*, *palo-de-Maria*, *palo-de-Brazil*, and others, for dyes and coloring matter.

LAUREL SABINO.—Color, clear olive-brown. Ducts occurring singly, evenly diffused in one or two irregular lines, between the indistinct medullary rays. A straight-grained wood, similar in color but finer grained than the heart of tulip and cucumber tree of the United States.

CEDRO.—Color, pale reddish-brown. Large ducts, few, occurring singly, irregularly grouped and scattered. Medullary rays few and indistinct. Wood fibers interlaced, the wood splitting irregularly. Very similar to the mahogany of commerce. Probably *Cedrela odorata*, the well-known cigar-box wood of commerce. It is no longer abundant in Porto Rico, and is now largely imported from Santo Domingo, costing \$150 per 1,000 feet. It still grows in Aguadilla and near Aibonito, Juana Diaz, Cayey, and Luquillo.

HUESO.—Color, light yellow, with irregular, thin, yellow-brown streaks. Conspicuous ducts in short, detached chains (1 to 2 rows of cells) evenly diffused. Medullary rays minute, but distinct. Wood fibers strongly interlaced (crossgrained). Tough, uncleavable wood. Used for hubs.

AUSUBO.—Color, clear, dull reddish-brown. Moderately conspicuous ducts in short, detached, long and short chains (single line of cells) evenly diffused; chains usually between two medullary rays. Medullary rays very numerous, minute, indistinct. Wood fibers slightly interlaced and appearing straight grained. Resembles somewhat a fine-grained teak. It is the chief and most-used timber on the island, being noted for its great durability. It is used in the making of wagon spokes, which are turned out by machinery in Ponce, and small stocks of it were noticed in several towns. It is close grained and beautiful in color, and should be utilized for veneering; it would make most excellent furniture.

UCARE NEGRO.—Color, dark umber-brown. Conspicuous ducts occurring singly and evenly scattered between the medullary rays; the latter minute, distinct. Wood fibers interlaced, but appearing to be straight grained. Remotely resembles a very fine-grained black walnut.

PATA DE CABO AND ALGARROBO.—These samples are so similar in details of structure as to be from the same or closely related species. Color, rich blackish-brown, irregularly mottled, and streaked with areas of pale reddish-brown; sapwood (present in *pata de caba*) light brown. Ducts conspicuous, occurring singly or two together, between

two medullary rays, or often interrupting a ray; evenly diffused. Medullary rays conspicuous, visible to the naked eye, often disconnected. Wood fibers strongly interlaced, giving smoothed surface a "curled" appearance. Very attractive cabinet woods. Resemble forms of mesquite, especially *Prosopis odorata*.

UCARE BLANCA.—Color, light ashy-brown. Minute ducts very numerous, occurring singly, and evenly diffused between the medullary rays. Medullary rays minute, very numerous, wavy, distinct. Wood fibers strongly interlaced. Remotely resembling fine-grained heartwood of American elm.

GUARAGUAO.—Light reddish-brown, streaked with lighter and darker shades. Large ducts numerous, occurring singly or in irregular loose groups of two to four. Medullary rays numerous but very indistinct. An exceedingly crossgrained, porous wood, somewhat similar in color to cedro. Suitable for a cabinet wood.

CAPA BLANCA.—Color, clear light brown. Very numerous ducts, occurring singly, and evenly diffused between the medullary rays. The latter numerous, in distinct parallel lines. Structurally similar on the radial section to American beech, the medullary rays giving a beautiful, finely mottled satiny appearance. Tangential section unattractive. Straight grained, and suitable for interior finish. Used for rollers in coffee-hulling mills.

CAPA PRIETA.—Color, rich light brown, with darker streaks and mottlings. Very numerous ducts, occurring singly or irregularly, aggregated in twos and threes between the medullary rays. Medullary rays numerous, indistinct, straight, parallel lines. Wood fibers interlaced, but wood appearing to be straight grained. Radial section structurally similar to capa blanca. Tangential section somewhat similar to dark heartwood of American elm. Handsome wood for interior finish. Used for flooring.

HACHUELO.—Color, rich, dark yellowish-brown, with streaks and mottlings of light yellow-brown. Ducts minute, very numerous, occurring singly, and irregularly diffused between the medullary rays, or often interrupting the rays. Medullary rays very numerous, indistinct. Wood fibers interlaced, but appearing rather straight grained on the finished surface. Valuable for cabinetwork.

MAGA.—Color, rich chocolate-brown. Conspicuous ducts few, occurring singly, and irregularly scattered between the medullary rays; mostly distinct, or occasionally two or three loosely grouped. Medullary rays comparatively few, distinct, but inconspicuous. Wood fibers slightly crossgrained, the smoothed surface appearing straight grained. Quarter and radially cut medullary rays have a satiny appearance. The rich color and attractive grain of this wood should make it valuable for cabinetwork.

ENDOGENOUS TREES USED FOR VARIOUS PURPOSES.

There are many species of palm upon the island, and as these trees are perhaps the most used by the natives of all the forest products, it is necessary to mention them. Combined in them are sustenance, clothing, and utensils for the natives of the Tropics. In Porto Rico the leaf of the palm is largely used for thatch and sheathing of the houses of the poor, and its broad leaves for washtubs and other domestic utensils. The following notes upon the palms are mostly taken from Fray Iñigo's *Historia*,¹ and although not modern they are instructive.

The Palma Moriche (*Cocos mauritia*) grows in damp, marshy soil from sea level to an altitude of 300 varas.² In this palm the Guaraunos Indians, who inhabit islands in the mouths of the Orinoco, find all that is necessary for food, drink, and clothing; for building their houses and furnishing them; for making their boats, ropes, and sails for their navigation, and apparatus for fishing and hunting. Concerning the uses of the Moriche or Sago palm, it has been said that "when the heat of summer has parched everything about this tree, travelers find at its roots water always cool, which escapes from subterranean veins. The most tender part of its fruit center serves as a garden vegetable to the natives, and from its young shoots they draw the cords which form their fish nets and from which they weave their hammocks. It is a refreshing nourishment before its fruit is matured, and when ripe it makes oil, soap, and pastes, which are sweetened with honey. With the dry leaves of this plant the Indians cover their huts, from its sprouts they manufacture mats, blankets, hats, and sails for their vessels. The trunk contains in its upper portion a sweet juice, from which a kind of wine is produced. From the trunk, boards and sometimes small boats are made. A natural texture which covers the cluster of fruit before it matures serves as caps for men and as skirts for married women. The palm, which does not bear fruit, furnishes a mealy pith, which is called *yuruma*, used for making bread and also pottage or soup. A thick, white worm is found in the rotten medulla, which is eaten and considered a great delicacy."

The yagua, or cabbage palm, grows on the plains and in the forests. It is very useful for covering houses, is tall, of ash color, and has the figure of a well-formed column; its pedestal is perfect, the trunk being larger in the middle and tapering to the point where the leaves appear and form a cornice, from which springs another column no less perfect, about 7 feet high and $2\frac{1}{2}$ feet in circumference, of an emerald-green color, smooth and lustrous. The upper column of the yagua palm is denuded of its bark every month, and this is called *hoja de jagua* (lamina or leaf

¹ *Historia Geografica, Civil y Natural de la Isla de San Juan Bautista de Puerto Rico*, por Fray Iñigo Abbad y Lasierra, etc. New edition, annotated by Jose Julian d'Acosta y Calbo. San Juan, 1866.

² The Spanish vara is 2.78 English feet.

of the *yagua*). The bark is flexible, very durable, and serves to cover houses and divide their interiors, to make chests and boxes for storing clothing and for transporting rice and coffee. On a journey the leaves are taken as a protection from heavy rains, and they serve many other uses.

The palm most highly prized by the Porto Ricans is called the "Palma de gravia" (or *grana*?), the "Royal palm." Growing to 100 feet or more, its slender trunk is crowned near its summit by leaves. A green shoot, delicate and pointed, from 10 to 12 feet in length, constitutes the upper end of the trunk. At the base of this terminal portion a fruit cluster from 3 to 4 hands in length, divided into different branchlets, grows out about once a month. This cluster is full of a green, olive-shaped fruit, larger than the *filbert*, the interior nut being covered with a green substance. This fruit of the royal palm is very useful in fattening swine, which is the only use made of it. In the other islands they extract an oil from this fruit which is very good for lights and other uses. The central part (the heart) of this palm is cooked and eaten like cabbage, and is sometimes prepared as a salad. The Indians call it the "pira" (pile or pyre). In Porto Rico it is rarely used, although it has an agreeable taste.

The palms called "coyures" are taller even than the royal palms; the fruit grows in clusters, but is smaller, and the hard, round nuts, much like the above, serve as food for swine. At the foot of the trunk of this palm is formed a tuft like a pedestal, composed of a mass of small roots, from which grow thick fibers. These reach to the upper portion of the palm and form the stem through which the sap passes. The negroes extract from this palm a vinous liquid which is very agreeable and healthful. It is used as a specific in cases of fever.

The palm called "corozo" (oil palm) is very common. Its tall trunk is entirely covered with sharp thorns 3 fingers in length. At the top it is crowned by very long fronds. Its fruit is in small clusters, composed of nuts as large as eggs, whose yellow covering is very hard and bursts when ripe. The inner nut is white, divided into three parts, less solid than the outer shell. Its taste is agreeable, but it sours in a short time. In Porto Rico the corozo serves as food for swine, but foreigners extract from its nuts an oil which is medicinal, and useful for many purposes.

The coco palm is found in great numbers on the plains and coasts, and is a profitable plant for cultivation. The external sheath of the cocoanut is composed of a multitude of fibers which form a nap of a reddish color, which is excellent for calking boats, as it resists water better than tow, and endures longer. The Indians make a cordage from this fiber, and sails for their boats, and in the dockyards of Guayaquil, Ecuador, they use no other calking material in repairing vessels. Beneath this exterior fibrous covering is another, the color of chestnuts, which is very hard, and, although elastic, is easily broken. A

fine oil is made from the meat of the cocoanut, which is used for lighting and cooking. The Indians make an intoxicating drink from the sap of the cocoanut tree, which at first has a bitter-sweet taste, afterwards becoming sour. In Porto Rico the nuts are utilized by drinking the water from them when young, by making sweetmeats from the meat, and by manufacturing drinking cups and other utensils from the outside shell. From the trunks of the trees the best palm boards are made for houses, because of their resistance to the inclemencies of the weather. There are masses of fiber at the base of the leaves, which appear like bunches of tow or bast. These are the fibrous remains of dried leaves which have lost their fleshy portion, and appear like pieces of cloth woven from thick tow. This is used for filtering and sifting.¹

Hardly secondary to the palms in point of usefulness is the bamboo cane. This beautiful plant may be seen everywhere, growing in graceful, feathery clumps. Its stem is used for fence posts, telegraph posts, and construction of the huts of the peasant. The individual joints are also used for utensils, flower pots, and for propagating the cocoanut seed.

TREES VALUABLE FOR VARIOUS PRODUCTS.

In addition to those trees used for construction, Porto Rico has many which yield other valuable products. In most Spanish countries, and especially in Porto Rico, trees, both cultivated and native, are utilized much more for their fruits, fibers, oils, resins, and cordage properties than for timber purposes. Throughout Porto Rico most of the standing timber growth is of this character.

It would be an extensive list which included even a small part of the useful tree-like plants of the island. Only those most noted for special products are given, all of which grow without planting or cultivation, except the manioc, cotton, coffee, and a few kinds of the cacao (chocolate tree). In describing these plants Fray Iñigo's book, previously cited, has been freely used.

RESINOUS AND OLEAGINOUS TREES.

The bixia tree, also called "bija" or "achote," is very common throughout the island, but more especially in the plains. It is small, the bark reddish, the leaves large and hard and of a dark green. Twice a year it yields fruit, bearing a prickly husk like a chestnut, which is full of seeds, small and fleshy, one of which placed in the mouth turns the saliva red for half a day. The inhabitants of the other West Indies extract the dye from this tree, which serves for the coloring of wool, cotton, and other raw material which is manufactured into cloth. "But in Porto Rico nobody gathers what the earth offers."

¹Copra, or dried cocoanut, which forms such an important article of commerce in the Pacific islands, is not exported from the Antilles.

The “*arbol de la cera*,” or wax tree, grows naturally, particularly in the plains and on the shores of rivers. It is about the size of the olive tree, or sometimes smaller. The fruit is similar to the pimienta of Castile. It has been proved by experience that each large tree, well filled, will produce 2 bushels of fruit. There are two crops per year, the first more abundant than the second, the former harvest continuing from March to May. From each half bushel may be extracted about 1 pound of wax. This wax, which is used by the natives for making candles, is brittle, and no method of rendering it flexible has been discovered; hence, it is worked with difficulty, and the candles made from it are liable to break.

Among the most useful of the plants found is the “emajagua,” or “majagua.” This is a small tree, or rather a shrub, from the short trunk of which sprout forth many long, straight twigs. From the fiber of these twigs ropes are made for all uses, especially for the rigging of native boats. Formerly this was the only cordage employed for the latter purpose, as it is very durable, although rough and difficult to handle.

No less useful and common is another small tree known as the higuereta (*Ricinus communis* Linn.), also called the Palma-Christi, which abounds on the coast. This tree is smaller than the last mentioned and has many knotty and twisted twigs, the leaves being divided into five lobes. It produces a bunch of berries similar to the coffee, which, when boiled, yields very clear oil. This serves as an illuminating oil, giving a clear light without odor and without smoke. It is also much used as a purgative, as a remedy for fevers, and the Indians apply the leaves for relief from headache. Only the negroes make any use of it in Porto Rico. In some gardens of Europe this plant is cultivated as an ornament.

The tamarind is found in the plains and in the forests. It grows equally well on the warm coasts and in the cool mountains. The tree is very large and spreading. Its trunk reaches 10 feet in circumference. The wood is hard and red in color. The fruit has a pleasant taste, neither sweet nor sour. Diluted with water it forms a delicate and wholesome beverage like that of the lemon, and is considered by some even more agreeable. Sweetmeats are made of the fruit; also remedies for fevers, vicious humors, scurvy, etc.

The papaya, or “papaw tree,” is found in the mountains and is grown near the houses, because the islanders enjoy the fruit as well raw as cooked in the “olla.” The tree is small, reaching 3 or 4 yards in height and less than a foot in diameter. It is straight, and has no branches; from the middle of the trunk to the top it throws out leaves. The fruit grows in the angle of the leaf where it is joined to the trunk, and covers the entire circumference of the latter in such a manner that it can not be seen from its middle to its top, being covered by papaws. The fruit is green at first, afterwards turning yellow within and without,

growing to the size of an ordinary melon. The very sweet pulp of the fruit is somewhat nauseous and insipid. Eaten with the seeds it has an agreeable taste, is strengthening, diuretic, antiscorbutic, acts as a vermifuge, and is used in making comfits.

The guañabana grows here, but is small. It blooms twice a year. The fruit is heart shaped, more than 6 inches in thickness, and a hand-breadth in length, ordinarily weighing from 6 to 7 pounds. Its color is green at first, then turns yellow, has a net-like covering, and some excrescences like grains. Its pulp is very white, tender, full of a juice which is nauseous because too sweet, and contains small black seeds like the watermelon. This fruit is used as a remedy for diarrhea and fevers, being very cooling and healthful. The juice extracted has the color and taste of muscatel wine, but it soon sours.

The tachuelo, or totumo (calabash) tree is found near all houses. This tree is quite large, its trunk and branches are crooked and knotty, with a few small, fleshy, lustrous green leaves. The fruit is oval, with a smooth, light-green and very compact, although pliant, covering, and on the tree presents different forms. The pulp is white, spongy, like that of the sandias watermelon, and the seeds resemble those of that fruit, but the taste is bitter and biting or acrid. The gourd-like fruit serves for plates, pitchers, spoons, and other domestic uses, furnishing most of the dishes and utensils of the poor. The guichero, or guiro, a peculiar musical instrument used by all the peasantry, is also made of it.

The tree called tabanuco, which yields a valuable resin, is common, especially in the mountain of Luquillo, and in high parts of the island. This resin is white, very bitter, and is said to kill the borer and other pests that destroy wood. For this reason it was used in former times for calking boats, and was of great utility because of its durability and value as an insecticide. It is sometimes employed in the churches for incense and as a remedy in some diseases.

No less useful are the resins of the trees called cupey, mora, algarroba, and especially that called pinuela. The latter makes a varnish-like cement so permanent that broken articles may be united so firmly that they never break again at the point of union.

The ceiba tree grows to over 100 feet in height. Its diameter is such that from its trunk canoes are made 50 feet in length and 10 to 12 feet in breadth. This tree produces a great quantity of pods, 4 inches in length and 1 inch in width, which are full of a fine soft down called *wool of ceiba*. When these pods mature they open and the wind carries away the contents. The same is the case with the tree called guao, which differs but little from this. Some value the wool highly for mattresses and cushions, because they are cool and soft.

The cañatistolo is not uncommon. The tree is tall, its wood hard, of a reddish color, and the leaves have the form of a lance. The tree is

covered with yellow flowers in the spring. The physicians call the pulp of the fruit *caña*, and purgatives are made from it.

Another tree which the forests contain produces the pimienta or all-spice. Although it is abundant and of the best quality, it is little known because of its limited exportation. It is ordinarily gathered by the natives only after falling from the trees when it is ripe, on wet soil exposed to rains and dews, which cause it to deteriorate. Therefore its condition when exported is not a criterion of its real quality. This tree grows among the forest trees of the southern coast of Porto Rico, especially in the districts of Guayama, Ponce, and Coamo, which are the dryest and least fertile in the island, the tree being rare on the northern coasts, which are fertile. Its stem is tall, straight, and smooth; the wood is hard and suitable for working, having a dark-reddish color, which in time becomes a lustrous black. Its bark is a silver gray, its branches rich in foliage; the leaves, which resemble the laurel, have the odor of pepper and serve for condiments and different remedies. In Jamaica and other places this tree is cultivated by transplanting it to uplands which will not serve for sugar cane. The pimienta is also gathered in Jamaica by beating the branches with a pole before it is perfectly ripe, and it is dried in the sun, protected from all dampness and dew. It is cleansed with care and put into bags for transportation to Europe, with which there is a prosperous commerce. In Porto Rico it is utilized mostly without any precautions for preserving it from humidity or any preparations for drying it in the sun, as it is gathered a few barrels at a time, the rest being abandoned.

No less common upon the southern coast and in the higher parts of the island is the tree which produces the nutmeg. Fray Iñigo, in his "Historia," says:

I will not venture to affirm that this is of the same quality as that which the Hollanders bring us with so much care from the island of Banda, one of the Moluccas, where they have endeavored to praise it to the disparagement of the trees of this species which grow elsewhere, or to define the class of aromatic nuts to which this belongs. Since I am lacking in the necessary information and knowledge to analyze and examine it with precision as to its quality, therefore it is necessary to leave undecided its exact name and species, contenting ourselves with saying that its form, size, color, odor, and other qualities differ but little from that which the Hollanders bring from Asia. Porto Ricans prefer this native spice to the imported for some uses, and if it were cultivated it would improve greatly, since the land which produces such good quality naturally would give better results by cultivation. This soil and the temperature of the island, as well as geographical position, are in no respect inferior to the Moluccas.

TREES VALUABLE FOR FRUITS.

The climate produces a variety of fruits, unusual in their growth and of excellent quality. The orange, lime, lemon, citron, guava, cashaw, anona, corazones, mamey, jobos, aguacate (alligator pear), mango, and other fruit trees of warm countries are common throughout the island. While it may be inappropriate to discuss these in a report upon the forests of the island, a few words concerning some of them may be of

value to the public, inasmuch as the growing of fruits is the most valuable prospective resource of the island.

Porto Rico is especially well adapted to the growth of citrous fruits. The wild or Seville orange in the country is an indigenous tree, which would prove a source of considerable revenue if properly appreciated by the makers of jams and marmalades. Of the cultivated oranges, there are two principal kinds which the people call "naranjos" and "chinos." The former term is applied to oranges in general, and the latter to an especially fine and sweet variety. No attempt has been made to cultivate the orange as an export product. Such trees as exist are the result of casual planting for shade, ornamental, and family use, just as an American may set out an occasional peach tree in his yard. The art of orange culture as practiced in Florida and California is unknown. When one considers the perfection and abundance of the Porto Rican orange and the demand for that fruit in this country, it is obvious that its culture offers a most profitable opening to the American investor. Limes, lemons, grape fruit, shaddock, tangerines, and other varieties of the citrous family can be cultivated with profit.

Although the banana is not properly a tree, still it is the most useful and the most cultivated fruit of the island, constituting the staple food of the inhabitants, especially the working classes. One is hardly ever out of sight of these plants, as they are grown around every hut and upon all the estates. They grow to a height of from 12 to 15 feet, and their trunk is a large roll of leaves in sheathlike form, one within another, having neither wood nor bark. The leaves are green, smooth, lustrous, and beautiful. Each stalk of the banana plant yields one bunch of fruit; this contains from 80 to 100 or more bananas. When the fruit is cut the plant is also cut, although it is renewed from the foot stalk three or four times, each shoot producing its bunch of fruit each year.

The species of banana called platanos or hortones are the most common and useful. When green and roasted they serve as bread; when ripe they are eaten raw, fried in butter, prepared in the Spanish dish called the olla-podrida, and baked. A very strong vinegar is also made from them. There are several other varieties of banana ("congos," "guineos," "cambures," "dominicos," and others) which are raised in the immediate vicinity of the houses: these plants differ from the hortones, being lighter green with smaller, sweeter fruit, more mellow, and delicious in taste. All these species of banana are abundant and delicate in taste, according to the quality of the soil in which they grow. Generally, they are planted in a rich, humid soil, and require no other cultivation than to be freed from the weeds surrounding them.¹

¹ Oviedo says "that the banana was brought to the island of San Domingo from the Gran-Canaria in 1516 by the padre friar Tomas de Barlanga, of the Order of Predicadores, and that from there they have been conveyed to the other islands and to the Continent, and that they originated in India, where they are called musas."

Notwithstanding the abundance of the banana in Porto Rico, no fruit is grown of the variety acceptable for export to our banana merchants. This is due to the fact that large and perfect bunches are required for this purpose, which the natives have never taken the trouble to produce.

Coffee is cultivated with great ease in all parts of the island, although in greater abundance and of better quality in some parts than in others. It grows rapidly and begins to yield in three years. The stem grows to a height of from 9 to 10 feet, and is ordinarily from 4 to 6 inches in diameter, the bark being whitish and smooth, the branches delicate and long, and the leaves, arranged in pairs, are always green, bright, and smooth, without odor, and with no special taste. The flowers resemble the jessamine, and are fragrant. The fruit is somewhat like the cherry. This is gathered by hand, the exterior pulp removed, leaving a thin scale around the seed, which is taken off in water troughs or by pounding in wooden mortars.

The coffee of Porto Rico is highly appreciated for its flavor by foreigners, who mix it with the Asiatic and South American products. For this reason it is preferred to that of the other islands, and is much sought after. The production is considerable, with the prospect of rapidly increasing under the change of government.

Traces of the former culture of the cacao plant, the cultivation of which has been almost entirely abandoned, is still found in many places. It is now cultivated only as a curiosity and in so limited a quantity that it scarcely supplies the demand. It begins to bear fruit three or more years after planting, according to the quality of the soil in which it grows. The branches are bent toward the earth, and need only be cleaned from the weeds in their immediate vicinity. They require much irrigation and warmth.

The yucca (manioc), which is commonly cultivated throughout the island, is a small tree, from 7 to 8 feet in height and from 3 to 4 inches in diameter. Its bark is reddish, its branches are crooked and knotty, its leaves dark green and cut like the fingers of the hand, and its flowers are yellowish and drooping. The roots of the yucca, which the negroes call *magnoc* and the Portuguese call *mandioca*, are grated and pressed to extract the juice, which is a virulent poison. From the grated root, which is like sawdust, the cassava bread is made and baked in a slow fire. The poisonous juice after boiling loses its bad qualities and is used as a flavor or sauce in serving fish.

There is a tall cotton bush or tree upon the island of the species *Gossypium barbadense* Linn., of which there are two varieties—one the synonym of *G. purpurascens* Poir., or the red cotton, and the other of *G. janiphæfolium* Bello., or the “algodon yucca” of the natives. This island is so well adapted to the culture of these species of cotton that they grow wild in many places. The cotton plant in Porto Rico grows

to a large bush, 10 or 12 feet high, the trunk or stalk is from 6 to 8 inches in diameter, and the branches produce many leaves. Notwithstanding this plant requires but little care, there are no plantations devoted to its culture, although all farms have a few plants. It produces two crops a year, that of September being more abundant than that of March. Rains and violent winds injure the plant, which requires frequent light rains and a dry, gravelly soil. It grows from the seed, and yields its fruit the ninth or tenth month after sowing.

There are many other fruits and plants. On some estates vines, fig trees, and pomegranates have been planted. They grow well and bear the whole year. Apples, plums, pears, cherries, peaches, and other trees of temperate climes do not bear fruit, even though they take root and grow.

POISONOUS TREES AND PLANTS.

The Antilles are comparatively free from harmful animals and poisonous plants, but there are a few species of the latter with which the traveler should become acquainted in order to avoid unpleasant consequences. Three of these are alleged to be especially injurious—the guao tree, the manchineel bush, and a small herb called the tibey.

The tree called guao (*Comocladia*), called by the Mexicans teilathiam, although useful for the juice extracted, is poisonous; it is alleged that it benumbs the person who rests under its shade and causes the hair of animals to fall off which rub against its trunk. It inflames for some days the hands and eyes of carpenters who work it. It is employed for making beds, because it drives away the chinch (or bed) bug, and its juice kills the wood borer which grows in articles made of wood.

The alleged effects of the guao tree upon man and animal have just been related, but more serious still are said to be the results of resting in the shade of the manzanillo or manchineel. This tree spreads throughout the seacoasts and river banks, is covered with regular leaves, its stem almost 2 feet in circumference, its bark smooth and delicate, the flowers rose tinted; it is loaded with small applelike fruit of a pleasant appearance and odor; the leaves resemble those of the pear tree; the entire tree is full of a milky juice, which exudes in the heat of the sun. According to current belief, as frequently related to the writer, the incautious traveler, attracted by the beautiful appearance of the manzanillo, rests in its shade, soon finds himself poisoned, and if the lacteal substance falls upon him from the leaves, or if he touches the leaves, he suffers as from an application of some blistering substance. It is also said that a fish which eats the fruit becomes infected, the gills becoming yellow and black, and one who eats the fish in this state is said to fall into a profound lethargy, with a general relaxation of all the limbs, according to the quantity of fish he has eaten. This effect, according to popular belief, continues twenty-four hours, and frequently results in death. The use of brandy or other

spirituous liquors or the drinking of sea water is considered beneficial as an antidote.

A small herb called the tibey, the flower of which resembles the lobelia, grows in the meadows and pastures of the island. Its poison is said to be so active that a horse or other animal eating of it dies in a short time. The natural instinct of the animal teaches it to avoid this dangerous plant as soon as the odor reaches him.

The cowhage abounds upon the limestone soils of Porto Rico. This is a tropical climbing plant, with beanlike pods, very much resembling huge brown caterpillars. They are covered by a multitude of fine poisonous hairs, which, when disturbed, irritate the skin like the sting of nettles.

VALUE AND USES OF TIMBER.

CONSTRUCTION.

Native woods are used in Porto Rico principally to make houses, carts, furniture, fuel, cigar boxes, troughs, and wooden mortars. The house construction is of two kinds—city buildings, which are made usually of stone, and country houses of hardwood lumber and palm thatch. In the city buildings the use of lumber is employed only for joists or rafters, sills, balconies, and occasionally for floors. The latter are usually of stone. In fact, the city houses are all built to economize timber products, and from the most ancient to the most recent all show that in their construction wood has been a much more expensive material than stone. The principal timbers employed are heavy beams, used for joists and rafters. These are usually hand hewn from native hardwoods, but in Ponce, American and Canadian pine is substituted in construction now going on. Country houses are built both of masonry and of wood, but largely the latter, especially in the remote districts. Nowhere did the writer see a single country house in the process of construction, except in one instance, at San Turce, a suburb of San Juan, and this was being built of imported wood. Although wooden houses constructed of native wood abound throughout the island, most of them bear marks of antiquity, many being roofed with the old Spanish tile, which has not been used for the past twenty years, since its general replacement by corrugated iron. The number and character of these houses show that native lumber has been comparatively abundant in times past.

The country structures of the better class consist of large spacious rooms, sufficiently elevated upon posts to allow what would be the lower story in the United States to be used for a shed for horses, carts, saddles, and other articles. These ground spaces are seldom if ever paved, and rarely planked in, and then only by coarse weatherboards a foot or more in width, without doors or windows. The upper story is alone used for habitation. It is usually constructed of hardwood uprights

and joists weatherboarded on the exterior, and has wide board floors. In most houses of the middle class there is no attempt at interior finish, such as walls or ceilings. The roof is usually pyramidal in shape, covered with corrugated iron or tile. The large rafters are utilized for swinging capacious hammocks and for storage. Around the house is sometimes a crude platform or porch used for drying purposes. The houses of the lower class are of several types, the principal kind being crude bujios or huts made of palm thatch, elevated upon low posts.

In the western part of the island, adjacent to the large coffee plantations, between Lares and Adjuntas, a species of tenement house for the laborers was observed. This consisted of a low one-story elongated house, about 10 feet in width and of various lengths, cut up into small apartments by partitions, with a common kitchen in the rear for the use of several families. The individual apartments, often inhabited by a family of ten or more, did not exceed the space of the average box stall in an American stable. These structures were made of plain upright boards, sometimes of American pine, and roofed with corrugated iron.

One superb country house, the residence of a wealthy coffee planter, was constructed entirely of native woods except the roof, which was of corrugated iron. This house was a combined residence and coffee mill; it was an oblong structure about 150 feet in length and 50 feet in width, surrounded by a covered balcony. The basement story was so arranged that a number of flat cars, the length of the width of the building, could be rolled under it. These cars were covered with coffee in the process of drying, and could be quickly shoved from beneath the building in times of sunshine and as expeditiously returned during the showers. The second story was the living apartment. This was beautifully ceiled and floored with rich brown native woods, smoothly dressed but unpolished. The gabled roof was used for the storage of dried coffee. In an L was a large coffee mill with pulpers, hullers, and polishers, all driven by water power, and constructed of beautiful native woods, principally hueso, maurito, and ausubo. Some of these woods, especially those used in the construction of the large coffee hullers, were exquisitely polished by contact with the workmen's bodies. This building, the property of Mr. Pietre, 4 or 5 miles west of Adjuntas, is said to be the most expensive and perfect coffee hacienda upon the island.

FUEL.

Native wood and charcoal are largely used for fuel upon the island. Cooking is done over open fires upon elevated braziers and with small limbs and twigs, mostly the natural waste of the cultivated trees or brushwood. This wood is costly, being sold in small bundles of fagots at the country stores, and is used with rigid economy. It is safe to

say that the daily consumption of fuel for domestic purposes, exclusive of heating, in an American family exceeds that of the weekly allowance of the average Porto Rican household. The ship upon which the writer traveled to Porto Rico carried as part of its cargo several hundred bags of charcoal and many barrels of petroleum for use as domestic fuel. This fact alone is a significant indication of the scarcity of forest products in the island.

MANUFACTURED PRODUCTS.

The principal use of woods upon the island at present is in the construction of the heavy two-wheeled ox carts, which, next to pack animals, are the most general means of transportation. These carts have large wheels with massive hubs, spokes, and fellies, and are tired with iron. These wheels, the wood for which costs \$20 per pair, have almost the rigidity and durability of iron, and upon any roads not as bad as those of Porto Rico would be practically indestructible. The hubs are made of guayacan, the spokes of ausubo, and the fellies of mora. They are made by hand in every city and village, and the principal stocks of lumber are those stored for their manufacture. In Ponce there is a small wood-working mill run by steam with modern machinery. If American manufacturers would make cart wheels of common woods of sufficient strength for the Porto Rican market the valuable island woods now used in these wheels could be saved for furniture veneers and other ornamental purposes. The native stock of woods for this latter purpose is not abundant, and much of the material is imported from Santo Domingo. Some beautiful furniture made of native woods may be seen in the houses of the well to do.

Throughout the country there are many huge mortars made of sections of trees and used for hulling coffee and rice and pounding corn. In the aggregate these represent a great cost of wood and labor. Troughs for feeding cattle are frequently seen. In Arecibo there are many large dugout canoes made from solid logs.

IMPORTS AND EXPORTS OF TIMBER.

It is impossible to ascertain the exports and imports of woods from and into Porto Rico, inasmuch as statistics are difficult to obtain. It is safe to say, however, that there are no considerable exports of woods, either crude or manufactured. Even the staple products of the island, sugar, coffee, and tobacco, are exported in packages of foreign material, the sugar and rum being largely disposed of in hogsheads and casks made of Louisiana staves, and the coffee in sacks of foreign make.

There are only a few items concerning the exports of woods from Porto Rico. From 1892 to 1896 cabinet woods were exported to Spain to the value of \$2,848. Small shipments of woods have been sent to the

United States, the value of which is trifling and the annual quantity most variable, as shown in the following table:

Imports of woods into the United States from Porto Rico.

Items.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Unmanufactured	\$5,233	\$342	\$1,469	\$4,613	\$519	\$1,062	\$80	\$1,592	\$149	\$579
Manufactured				139	3	222	111	147

A little wood may also have been sent from Porto Rico to England and France, but inasmuch as the total nonagricultural exports of the island are annually less than \$10,000, the aggregate quantity of the export lumber trade must be inconsiderable.

On the other hand, Porto Rico imports woods and manufactures of woods quite extensively, principally from Canada and the United States, and a little from Spain. Col. Fred A. Hill, who has been collector at the port of Ponce for the past eight months, informed the writer that the principal imports of wood consisted of spruce and hemlock from Canada and New Brunswick. In 1895 the United States sent wood and its manufactures to Porto Rico to the value of \$840,511. During the four years 1892-1896 Spain exported to the island the same articles valued at \$71,267, our exports for the one year, 1895, having been over ten times as great as that of Spain for four years.

The following facts concerning the exports of wood and the manufactures of wood from the United States to Porto Rico are taken from Bulletin No. 13, Section of Foreign Markets, U. S. Department of Agriculture, entitled *Trade of Porto Rico*:

During the last five years (1893-1897) our exports of wood and its manufactures to Porto Rico reached an average annual value of \$292,336. Although these figures are somewhat larger than those for 1888-1892, returned at \$285,773, an examination of the records for earlier years shows that this slight increase was preceded by a long period of decline, dating from 1871, when the value of the exports was at its highest, amounting to \$900,407.

Lumber and timber form the principal portion of the exports under this item, the value of the wood manufactures sent to Porto Rico being comparatively small. The lumber exports consist chiefly of boards, deals and planks, shooks, and staves and headings. Under the head of wood manufactures house furniture is the leading export. The average yearly value of the lumber and timber exported amounted to \$254,191 in 1888-1892 and to \$267,036 in 1893-1897, while that of the wood manufactures was only \$31,582 for the former period and \$25,300 for the latter.

Following are annual statistics as to the value of wood and its manufactures exported from the United States to Porto Rico during the ten years 1888-1897:

Value of wood and its manufactures exported from the United States to Porto Rico during the fiscal years 1888 to 1897, inclusive.

Articles exported.	1888.	1889.	1890.	1891.	1892.	Annual average.
Wood, and manufactures of:						
Lumber—						
Boards, deals, and planks.....	\$97,454	\$79,470	\$70,419	\$94,266	\$114,791	\$91,280
Joists and scantlings.....	1,623	6,262	5,714	11,573	9,658	6,966
Hoops and hoop poles.....	17,561	13,887	13,659	7,349	13,933	13,278
Shingles.....	903	1,005	1,229	1,438	1,052	1,125
Shooks.....	133,816	145,737	129,406	74,383	35,239	123,717
Staves and headings.....	14,757	13,752	11,663	6,114	19,800	13,217
All other lumber.....	1,369	3,531	1,537	2,659	2,721	2,363
Timber, sawed.....		6,630	3,883		714	2,245
Manufactures of wood—						
Doors, sash, and blinds.....	29	3,062	-----	25	131	649
Moldings, trimmings, and other						
house finishings.....		11	12	12	110	29
Hogsheads and barrels, empty.....	1,690	447	190	115	1,396	768
House furniture.....	19,186	27,397	24,192	25,046	20,952	23,355
Woodenware.....	789	910	916	350	864	766
All other.....	3,894	9,703	5,148	7,590	3,742	6,015
Total wood, and manufactures of.....	293,071	311,804	267,968	230,920	325,103	285,773

Articles exported.	1893.	1894.	1895.	1896.	1897.	Annual average.
Wood, and manufactures of:						
Lumber—						
Boards, deals, and planks.....	\$133,341	\$161,697	\$134,587	\$117,186	\$122,524	\$133,867
Joists and scantlings.....	15,731	11,105	7,450	6,763	1,986	8,607
Hoops and hoop poles.....	8,183	10,040	(a)	(a)	(a)	b 9,112
Shingles.....	125	2,605	1,707	446	1,188	1,214
Shooks.....	76,731	107,160	112,742	113,565	75,907	97,221
Staves and headings.....	28,311	18,516	11,855	14,127	9,360	16,434
All other lumber.....	4,605	9,470	4,915	5,000	2,506	5,299
Timber—						
Sawed.....	46		3,300		60	681
Logs, and other timber.....	340					68
Manufactures of wood—						
Doors, sash, and blinds.....	2,320		24			469
Moldings, trimmings, and other						
house finishings.....	143	340	212	64	201	192
Hogsheads and barrels, empty.....	2,151	326	421	518	349	753
House furniture.....	25,624	22,521	18,120	16,518	15,700	19,697
Woodenware.....	941	577	397	547	497	592
All other.....	3,955	2,869	2,510	4,897	3,759	3,598
Total wood, and manufactures of.....	302,547	347,226	298,240	279,631	234,037	292,336

a Not separately stated.

b Annual average 1893-94.

Tropical woods are imported from Santo Domingo in small lots by the native boatmen of the latter island. This trade is inconspicuous. Spanish cedar for cigar boxes is also imported in limited quantities from Cuba and Haiti.

The island offers a good prospective market for hardwood timber for use in cart construction. The writer is inclined to believe that the Porto Ricans are making a mistake in using pine as a substitute for rafters in their durable masonry buildings, inasmuch as it is much more liable to destruction from rot and insect ravages than the hardwoods of the island. This country could supply them with oak beams for

this purpose, and American mill men would do well to consider this phase of the subject.

The island offers a good market for manufactures of woods of all kinds, especially carriages, wagons, furniture, and agricultural machinery. The furniture in general use, like all other conveniences in the island, is of the crudest and simplest kind. There will be a good market upon the island for tables, chairs, cot forms, store furnishings, coffee fans, practically the old-fashioned wheat fan of this country, washtubs, buckets, corn hullers, churning, and nearly all the conveniences which the people of the United States consider indispensable, but which as yet are hardly known in Porto Rico.

LUMBERING.

Such native lumber as is procured is obtained as follows: A desirable tree being discovered, the natives proceed to it with axes and whipsaws. It is felled and squared with the ax. A large circular groove

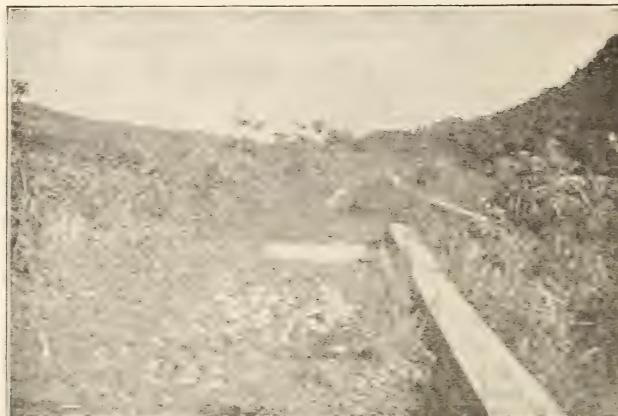


FIG. 8.—Logs on road from Sierra Yunque.

is cut around one end of the log, making a notch, in which ropes can be secured for hauling. The squared log is sometimes lifted upon temporary trestles and sawn into thick slabs (tablos). These planks are not completely severed, however, but are left attached by a foot or two of unsawn wood at the notched end of the log; the log is then dragged by ropes or pried along on rollers through the jungle, often many miles, until a beaten trail is reached. It is pulled by hand down these trails until they lead into the ox-cart roads. Oxen are now attached to the logs and they are dragged to their destination. There is not a sawmill in Porto Rico for lumbering purposes, nor is there any inducement for the establishment of such a mill, because sufficient logs could not be obtained in any one locality to supply a mill, and the topographic obstacles forbid hauling over great distances. The logs, after being cut and

dragged to their destination, are worked up upon the sugar plantations or in the cities into the objects for which they were hewn.

Capt. A. C. Hansard, an intelligent English ex-army officer, who is cultivating coffee in the eastern end of the island, says there are considerable areas of forest land on the Luquillo Mountains in his vicinity, but it is almost impossible to get the timber down to the sea. The reason of this is apparent to one who attempts the ascent of these mountains. The coffee cultivation and deforestation has proceeded up to about 2,000 feet, but even to this altitude there are no highways or even decent trails. The latter are so bad that one wonders how the natives manage to get the coffee down to the coast in 100-pound sacks packed upon the backs of men or sure-footed ponies. The trails are soggy paths of slippery and sticky red clay, winding and bending with the drainage. There are no cliffs over which logs can be hurled, as in the high sierras of Mexico, but they must be slowly pulled and dragged



FIG. 9.—Trees planted to shade military road.

by hand, the benefit of gravity being largely offset by the short turns and bends. Nevertheless, logs are occasionally taken down from these hills. Between Carolina and La Salta the writer saw ten or twelve logs which had been cut in the Luquillo range; they were lying by the roadside awaiting propitious weather for further removal. A gentleman stated that they had been in transit from the mountain summit a few feet a day for several months, and they were still 7 or 8 miles from the coast country. They had been dragged by oxen where possible and elsewhere rolled and pulled by manual labor. (See fig. 8.)

PROBLEMS OF REFORESTATION.

Porto Rico presents an interesting field for the practice of economic forestry. The climate, geologic structure, and soils are all well adapted to the growth of trees, and the forest question upon this island, plainly

stated, is that of reforesting a deforested region. That trees will grow rapidly and readily is shown by the many superb specimens of cultivated trees seen around the houses, and especially the shade trees planted along the highways by the late Spanish Government. One interesting phase of the Spanish road-building experiments was the planting of avenues of trees along the macadamized highways as far as they were constructed. (See fig. 9.) These trees have grown with remarkable rapidity, and are now shedding a grateful shade over what would otherwise be sunny stretches of highway. Many deforested mountain slopes and summits which have been abandoned as agricultural land could be rapidly reforested. Such a proceeding would be profitable even for fuel, considering the high prices of that article upon the island.

The rough limestone hills of the south coast of the island are well adapted to the cultivation of logwood and fustic, which have been introduced into so many of the West Indian Islands, and now practically run wild. The growing of oranges will be one of the future resources of the island, and much land will naturally be converted into orange groves.

We have here the problem of extensive tree culture upon a beautiful island once densely covered with forests, but which has been robbed of them through three hundred years of exhaustive cultivation of heavy plantation crops, in which alone, under the old political conditions, values were procurable. The conditions are altogether favorable, and the visitor to Porto Rico ten years hence should see the now cleared slopes of the numerous barren mountain sides covered with many productive trees.

BOTANICAL NAMES OF SPECIES.

[Names used in bulletin in roman type; botanical names in *italic*.]

Aceitillo (?)	<i>Simaruba amara</i> Aubl.
Algarrobo	<i>Pithecellobium saman</i> Benth. <i>Hymenaea courbaril</i> L.
Ausubo	“ <i>Sideroxylon auzuba</i> Plum.” <i>Sideroxylon masticodendron</i> Jacq.
Aguacate	<i>Persea gratissima</i> (avocado, or alligator pear).
Bixia	<i>Stillingia sebifera</i> Michx. (arbol de la cera).
Bread fruit tree	<i>Artocarpus incisa</i> L.
Bucare	“ <i>Erythrina bucare</i> ” (also <i>E. umbrosa</i> H. B. K.).
Cabbage palm	<i>Oreodoxa oleracea</i> Mart.
Cañafistolo	<i>Cassia fistula</i> L.
Capa blanca	<i>Cordia alba</i> Roem. & Schult.
Capa prieta, or prieto	<i>Cordia gerascanthoides</i> H. B. K.
Cedro	<i>Cedrela odorata</i> L.
Coco	<i>Cocos nucifera</i> L.
Cojoba	<i>Copaifera hymenaeifolia</i> Moric.
Cowhage	<i>Mucuna pruriens</i> D. C.
Corozo del Orinoco	<i>Martinezia caryotifolia</i> H. B. K.
Coyures.	
Espejuelo.	
Frangipanie	<i>Plumeria alba</i> L.
Guama	<i>Inga laurina</i> Willd.
Guao	<i>Comocladia</i> sp.
Guava	<i>Inga vera</i> Willd. (a forest tree).
Guayacan	<i>Guaiacum officinale</i> L.
Guayava	<i>Psidium guajava</i> L. (edible guava).
Guaraguao	<i>Guarea trichilioides</i> L.
Guayarote	<i>Dioscorea</i> sp.
Guinea grass	<i>Panicum maximum</i> Jacq.
Hachuelo, or tachuelo	<i>Crescentia cujete</i> L. (calabash tree).
Higuera	<i>Ficus carica</i> L.
Higureta	<i>Ricinus communis</i> L. (palma-christi).
Hueso	<i>Drypetes alba</i> Poit, <i>D. incurva</i> Muell., and “ <i>D. latifolia</i> .”
Ileucedran (?)	
Jucare.	
Jagua	<i>Genipa americana</i> L.
Jaiti	<i>Gymnanthes lucida</i> Sw.
Laurel blanca	<i>Acrodielidium jamaicense</i> Nees.
Laurel sabino	<i>Talauma</i> sp. (Eggers).
Madres de cacao	<i>Erythrina umbrosa</i> H. B. K.
Maga	<i>Thespesia grandiflora</i> D. C.
Mamey	<i>Mammea americana</i> L.
Manzanillo	<i>Hippomane mancinella</i> L. (manchineel).
Maricao	<i>Byrsonima spicata</i> Rich.
Mauricio	<i>Magnolia portoricensis</i> Bello.
Moca	<i>Andira inermis</i> H. B. K.
Mora	Fustic.
Moriche	<i>Mauritia flexuosa</i> (?) (a species of palm).

Ortegon (?)	<i>Coccoloba macrophylla</i> Desf.
Palma de gravia, or grana.	
Palo santo	<i>Jatropha peltata</i> Cerv., also <i>Saneas guayacan</i> .
Pata de caba	(Palo santo of Bolivia and Brazil = <i>Triplaris</i> , several sp.)
Pawpaw	<i>Carica papaya</i> L.
Quiebra = Hacha	<i>Schmidelia occidentalis</i> Sw.
Royal palm	<i>Oreodoxa regia</i> H. B. K.
Sandbox	<i>Hura crepitans</i> L.
Sea grape	<i>Coccoloba uvifera</i> L.
Tabanuco	<i>Amyris hexandra</i> .
Tachuelo	Hachuelo (?).
Tamarind	<i>Tamarindus indica</i> L.
Tibey	<i>Isotoma longiflora</i> Presl.
Tortuguillo.	
Ucar, Ucare or Jucare.	
Wax tree. (See Bixia.)	
Wine palm	<i>Caryota</i> sp.
Zerreuela	<i>Smilax mollis</i> Humb. & Bonpl.



